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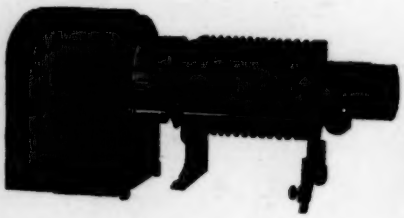

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SCHOOL SCIENCE AND MATHEMATICS

VOL. XX, NO. 4 APRIL, 1920 WHOLE NO. 168

SOME FACTORS AFFECTING THE SELECTION OF THE HIGH SCHOOL COURSE OF STUDY AND METHODS OF TEACHING OF MATHEMATICS.

BY H. R. DOUGLAS,

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THE THEORY OF FORMAL DISCIPLINE.

Mathematics is one of the oldest subjects in the curriculum of secondary schools. It constituted a very important branch of study as far back as the early Egyptian civilization thirty centuries ago. The scholars of the Hindus, the Chinese, and the Greeks were mathematicians, and the study of mathematics was an integral part of the learning of those peoples. Arabian civilization emphasized mathematics and left to us very important additions to the science. All through the middle ages, mathematics, along with the classical languages, occupied a considerable time and place in the studies of the schools of the times. From the time of John Sturm's gymnasium to the present, mathematics has been looked upon as one of the primary subjects of education.

Until recently its place has never been doubted or its values questioned. Aside from its utilitarian, its preparatory, and its cultural values its supposed value as a disciplinary agent has been considered enough to insure its retention. It has been perhaps this value that has been most emphasized. All through the past centuries mathematics has been looked upon as being with the languages the chief trainer of the mind. Because of the importance attached to this value of the study, the material has been chosen with little else in mind than a systematical, logical presentation of the field of mathematics. Depending as it has upon the theory of formal discipline, there has been for a long period of time but little change in the subject matter and methods of teaching as little there might need be in such a case.

In the last century there has appeared a tendency to consider more and more seriously its other values. It is becoming fundamental that the subject function directly and definitely if it should retain its prestige. Business arithmetic and the mathematics of physics are examples of this principle. Not only must the subject of mathematics train the mind, but it must also be taught so as to be of practical value in actual life. This tendency was wonderfully augmented by the tremendous force with which the older theory of formal discipline has been attacked in recent years.

In their history the theory of formal discipline and mathematics have had much in common and have been interrelated closely. Immediately upon the working out of the subject matter of mathematics, that is, immediately after sufficient material had been worked out to make mathematics an organized branch of study it was taken under the wing of formal discipline. Mathematics was used to sharpen the intellect; a material for mental practice to produce mental keenness. Plato in his *Laws* sets forth the value of mathematics in the following words:

"No single statement of youthful education has such a mighty power both as regards domestic economy and politics, and in the arts, as the study of arithmetic. Above all, arithmetic stirs up him who is by nature sleepy and dull and makes him quick to learn, retentive, shrewd."

All through the ancient and medieval career of mathematics and the formal discipline school, the cause of one has been the cause of the other, and together they weaken in the recent present under the onslaught of common criticism. The place of mathematics in the high school curriculum depends, as it is now organized, to a considerable extent upon the amount of the transfer of training. The question of the transfer of training is an open question. During the twenty years just past much attention and thought has been devoted to the discussion; as yet there is no exact agreement among any considerable number of recognized authorities. The leading students of education and psychology have practically all set forth in some manner their belief in the matter, either explicitly or impliedly. Out of the affair there seems to arise one theory stronger perhaps than all others but as yet only a theory. While some little experimental evidence seems to corroborate it, actual conclusive proof is only begun. This is the theory of identical elements. It is probably best stated by Thorndike who stands sponsor

for it: "Improvement of any one mental function or activity will improve others only in so far as they possess elements common to it also." He explains that identical elements may be either elements of procedure, or elements of substance. Henderson, Heck, O'Shea and a number of others lean toward this hypothesis and it is implied in educational practice widely.

At any rate it is pretty well recognized that whatever function is to be trained must be trained in situations as nearly like those in which it will be expected to function as possible. We may add to this another precept, which is a recent contribution from the investigation made in this field, namely, that the connection between the situation in which the training is being made to the possible situations of applications must be pointed out and emphasized at the time of training. For instance, to insure that the Pythagorean formula will function most efficiently in the life of the pupils, its possible practical applications must be pointed out to the pupil in the process of learning. In the case of the development of an ideal through a special field, the attention of the pupil must be directed to the operation of that ideal in other particular fields and in fields in general.

If this idea of discipline be accepted much that is now algebra, geometry, and trigonometry as taught in high schools will find itself on foundations of sands. Those portions of these subjects that do not have much in common (identical elements) with the future life of the pupil will be most likely to disappear from the course of study. Already we have courses in general mathematics being organized, the starting point in which is situations in everyday life. Smith somewhere claims that if only such mathematics is to be taught as will be of actual practical use later on, two-thirds of the present subject matter will be eliminated. That a great deal of this material might well be omitted is a fact worthy of consideration. However, much of this material must be retained on the basis of its value in developing other mathematical facts and principles, which do possess the value of utility.

The tendency is away from pure mathematics and towards applied mathematics, as should be especially in view of the more recent ideas on discipline. Efficient discipline necessitates the use of situations in teaching similar to those that will occur in the future life of the pupil. Textbooks will be accordingly modified. Mathematics as applied to industry, business, and other phases of vocational life will become the new order.

The organization will be from the basis of life problems, and such mathematics will be used as will solve them. Knowledge and skill in mathematics will be acquired from situations similar to those in which they will be used. Learning mathematics will tend to relieve itself of its analogy to the situation of learning to swim out of water. True development of the control can be brought about only in the presence of the medium to which the control is to be applied.

College Entrance Requirements.

The influence of greatest strength perhaps upon the shaping of high school curricula in mathematics has been the college entrance requirements. It has been the chief purpose, whether avowed or implied, of a far too large proportion of secondary schools to prepare for college. In fact the secondary school came well near being termed the preparatory school. The effect of the college upon the high school has been of serious strength and importance. High school textbooks have been written almost uniformly by college professors and almost as uniformly from the viewpoint of college standards of scholarship and with the lack of teaching psychology. High school teachers are, in the main, college graduates with ideals of college scholarship and with methods of college teaching fresh in mind. The composition of the secondary teaching force and teachers has done much to shape the course of study and determine methods of teaching in the high school. A third source of college influence, that of the college entrance requirements, has for decades shaped the educational policies of secondary schools. If the tendency has been to require two units of mathematics for instance, the tendency has been among high schools to offer, if not to require, that amount of mathematics for graduation. If but two years, one of algebra and one of geometry are required by the college then these two units are likewise offered or required by the high schools.

However powerful these three factors of college domination have been in the past, events have taken place in the last decade to assure one that this influence is waning. High school texts are beginning to be written by successful high school teachers. One of the most popular high school algebras is written by a triumvirate, two of whom are teachers of mathematics in high schools in western cities.

With the rise of teachers' colleges and chairs and department

of education in colleges and universities, high school teachers are beginning to employ methods of teaching more suitable to adolescents than the college methods they have been imitating in the past. They learn that while method and psychology are not of fundamental importance to the college instructor, they are more less fundamental in teaching mathematics to the high school pupils.

But chief of these forces operating to weaken the influence of the college among secondary schools is the receding of the committee on college entrance requirements from a dictatorial attitude. Whereas, a few decades ago, at least three units of mathematics were required for entrance to the most colleges and universities, only two are now required by a majority of higher schools, and some are in the front rank of a coming movement and require no mathematics at all except for entrance to certain departments in schools.

In making up our high school courses in mathematics we need not feel called upon to insist upon the traditional course for reasons of college domination. If it becomes necessary to change or rearrange the time spent on algebra and geometry for utilitarian or disciplinarian reasons we need not hesitate to do so for fear of maladjustment with the higher schools.

What Shall Be Included?

There arises the question: Who knows, and how shall we determine what to include in a course of study organized on the basis of life problems? The answer is pointed—no one knows. It is a matter that remains yet to be worked out. It is very probable that there will never be more than a general agreement on the point. But it is certain that improvement will be rapidly made upon the present practice of teaching mathematics in its entirety, treating all parts impartially, regardless of present or future importance, and with little attention paid to the applications that can be and are made of the various elements of the subjects.

How shall we set about to determine what are the things desirable to be taught, emphasized, applied, etc: what elements are most identical with situations of life? Which are of most disciplinary value, and which prepare best? Suppose, for a moment, that we had no schools, no traditional courses of study, no traditional subject matter within those courses and no traditional methods of teaching: What would be correct *modus operandi* of formulating a course of study?

It is not unlikely that, first of all, we should turn back and examine for what purpose we wish to establish and maintain schools. We examine the numerous statements of the aim of education. We find that they are as various as they are numerous. Upon one point however they are all agreed. Education should be a process by which individuals should be changed or developed into individuals somewhat different. That is, they all set as the goal of instruction, the changing of an individual from what he is to what he should be. The points of difference are as to what he is, what he should be, and how the change may be best brought about.

Teachers of mathematics must show that mathematics aids essentially in developing an individual from what he is, to what he should be or mathematics cannot be included in such a curriculum. Mathematics to be best insured its place in the curriculum must be organized so as to contribute the most possible to such development.

The individual to be changed is the high school boy and girl, the adolescent. What he is educationally is the totality of his ideals, desires, likes, opinions, ambitions, purposes, instinctive and habitual goals—his values, and his method of behaviour, his powers, capacities, weaknesses, intelligence, knowledge, abilities, his means of control of values.

Values of Society.

What he is to become, is the goal of education. What is this goal in definite terms? What the values worth while are, and how they may be attained, has always been a point for discussion and investigation. Below we find a number of the aims of education of different nations and leaders which are the formulations of the values thought to be most worth while by those nations and leaders, and which we should probably examine before settling in our minds on a system of values.

Aims, Past and Present, of Education.

1. Egyptian—to train priests and scribes.
2. Chinese—to preserve the past, prevent change, and hand down Confucianism.
3. Hindu—to prepare for life to come.
4. Hebrew—to train in religion and morals.
5. Persian—to produce soldiers.
6. Greek—(a) Prehistoric—to make pupil wise and eloquent in council, and strong and courageous in battle.
   (b) Spartan—to make hardy warriors and patriotic citizens.
   (c) Athenian—to develop personality and live happily.
7. Socrates—to develop individuality in power of thought.

8. Plato—to determine what each individual is best fitted to do and then to prepare him for that service.
9. Aristotle—to provide properly equipped and properly disposed citizens.
10. Roman—to train for the professions.
11. Early Christians—morality and self denial.
12. Scholasticism—to systematize and master knowledge; to train the logical power and ability to dispute; to strengthen faith by the development of reason.
13. Renaissance—free development and liberal culture of the individual in the spirit of the revival.
14. Vittorino da Feltre—to prepare for a useful and balanced life in leadership in State and Church.
15. Sturm—piety, knowledge, eloquence.
16. Humanistic Realism—to master his own environing life, material and social, through a knowledge of the broader life of the ancients.
17. Jesuits—to strengthen the authority of the papacy and combat Protestant theories.
18. Milton—to fit a man to perform justly and skillfully and magnanimously all the offices both private and public of both peace and war.
19. Nulcaster—to aid nature in perfecting the mental and physical development of the pupil.
20. Comenius—to assist in attaining eternal happiness with God.
21. Locke—to fashion the carriage and form the mind, to settle in the pupil good habits and the principles of virtue, to give him, little by little, a view of mankind and work into him a love and imitation of what is excellent and praiseworthy, and the prosecution of it to give him vigor, activity and industry.
22. Pestalozzi—the natural, progressive and harmonious development of all the powers and capacities of the human being.
23. Herbart—to establish moral life or character.
24. Spencer—to prepare for complete living.
25. Horace Mann—moral character and social efficiency.
26. Eclectic Aim—a type of mind that includes power of rational insight.
27. Dewey—to remake experience, giving it a more socialized value through individual experience, by giving individual better control over powers.
28. Strayer—to form habits of thought, feeling, action, acquiring knowledge of nature and society, forming ideals which make for social well being, learning to act independently, to function in society.
29. Butler—"these five characteristics then I offer as evidence of an education—correct and precise use of the mother tongue; refined and gentle manners, which are the expression of fixed habits of thought and action; the power and habit of reflection; the power of growth; and efficiency or the power to do.
30. Brown—the harmonious development of human power for a life of service in the society and state, with due regards for peculiar needs, inclinations of the individual as far as his own happiness and his social efficiency are concerned.
31. Parker—social efficiency, good will and the harmless enjoyment of leisure time. (Broad ultimate aims)—health, information, habits, ideals and abiding interests. (Detailed or immediate aims.)
32. Inglis—vocational, avocational, civic.

The foregoing aims or purposes of education, as might be expected, show extreme variability. This is due to a number of causes. Ideals and conditions of society change from time to time, and vary widely among individuals and groups at the same time. The conception of the function of the school has

varied widely from time to time and with different people and peoples. The school's share in the education of the young has been a matter subject to change, varying with the scope of the church, home, street, and other social organizations. In the last analysis, however, we will find that the function of the school is to assist the individual in getting before him the values of society and in acquiring the greatest amount of efficiency in the technique of controlling these values.

As we have found a variety of opinion concerning the aims of education, we shall expect to find a variety of opinion as to what are the values of society, and a greater variety as to what is a correct ranking of them in importance. Following is a list of values of society, perhaps not at all exhaustive, surely overlapping, and surely not a set upon which any startling uniformity of opinion might be secured, yet certainly adequate in the main as a classification serviceable as a basis from which to work.

1. Health or vital efficiency.
   a. Ability to avoid disease.
   b. Ability to build up the body.
   c. Ability to improve transmittable characteristics.
2. Economic efficiency.
   a. Ability to provide a living for self and dependents.
   b. Skill in conserving and disposing of goods.
3. Moral efficiency.
   a. Self control.
   b. Correct ideals—(ideals conducive to the best interests of individual plus society).
   c. Correct influence and example for others.
4. Social efficiency.
   a. The quality of being an agreeable unit in society.
   b. Insight into purposes and characteristics of social body.
   c. Spirit of coöperation and technique of same.
   d. Appreciation of harmless or profitable enjoyment.
5. Civic efficiency.
   a. Intelligent exercise of franchise.
   b. Intelligent discharge of official duties.
   c. Patriotism.
   d. Law-abiding qualities.
6. Mental efficiency.
   a. Cultivation of powers by disciplines.
   b. Healthful mind.
   c. Wide, rich, varied experience.
7. Religious efficiency.
   a. Development of adequate philosophy of life and immortality.
   b. Self-direction.
8. Domestic Efficiency.
   a. Home-making.
   b. Rearing and care of young.
   c. Marital agreeability.

These are the values for which we are to work. What have we to work with? We have on the one hand the children to be educated, upon the other, the mathematical experience of the

race. We must assume that those who essay to teach mathematics have an adequate hold upon this experience. We should be in a position to assume that they likewise have an adequate knowledge of the nature and development of children. But it is far from likely that such is the case. It is a fact that teachers collectively possess far more adequately the necessary subject matter qualifications than they do those pertaining to a knowledge of the children they are to teach.

We have said that education must function to develop the individual from what he is to what he should be. We might have said that education serves to develop from the values and controls of the adolescent, the values of society and the controls of the same.

The Values of the Adolescent.

So far we have only set up the values of society. Let us now suggest some of the values of the adolescent. For this discussion we shall rely largely upon our conclusions from a reading of G. Stanley Hall's "Adolescence." The following is a classification of a number of adolescent values reduced to somewhat general heads. Under each is listed a few typical controls the adolescent has of that particular value.

1. Pleasurable activity.
   Music, dancing, play, companionship of other sex, of own sex, organizations, college life, stories.
2. Development.
   Exercise, play, school, companionship, ideals, adult society, nature, courage, ownership, vocations, and dancing.
3. Excitement.
   Music, dancing, leadership, myths, biography, religion, other sex, pugnacity, play, stories.
4. Prowess.
   Play, other sex, physical bigness, leadership, adult society, ownership, slang.
5. Excellence.
   School, play, music, religion, dancing, activity, ideals, vocation.
6. Sociability.
   Adult society, cliques, organizations, other sex, school, college life.
7. Approbation.
   Adult society, school, parental association, play, music, dancing, courage, physical prowess and growth, ownership, slang.
8. Rationality of nature and human artifice.
   Nature, science, commerce, government, industry, history, biography in the matters of cost and building.

Mathematical Controls.

In attaining economic efficiency a larger field of usefulness presents itself to mathematics. Vocations of all sorts depend somewhat upon the manipulation of number, and usually upon

a conception of space and figures. This, of course, varies. The surveyor, for instance, needs considerable knowledge and training of a mathematical nature, the hod-carrier not so much. Economic efficiency depends also upon disposal and conservation of income as well as the obtaining of it. Life insurance, banking, all sorts of investments need a higher type of mathematical proficiency than is obtained from a study of the four fundamentals.

That mathematics contributes to moral efficiency in any large degree might be open to question. Yet no subject in the curriculum puts such a premium upon truth and accuracy as does mathematics. Ideals such as neatness, accuracy, speed may be developed from all parts of mathematics.

Social efficiency demands culture. That such is obtained from mathematics in general is at least plausible. Its value, however, depends somewhat upon the subject's being accepted as culture. Again in order to understand social facts and principles, a sense of proportion responsive to stimulation by statistics and graphs is necessary. To be socially efficient one must understand social institutions. Business arithmetic affords a well worked out starting point and basis for the study of business institutions, practices and devices. Socialized arithmetic belongs not to the elementary grades as experience will show, but should be presented at a later time when the pupil has arrived at that age when by means of a better developed social insight, he is capable of assimilating and appreciating social information.

Civic efficiency again brings us to the subject of statistical representation. A knowledge of graphs and an appreciation of the relativity of numbers is necessary to the best understanding of articles and books bearing on civic and governmental questions and political issues.

Mental efficiency, a condition of having a mind and mental development well suited and well trained for the situations to be experienced by the individual, calls for, among other things, a rich, wide, and varied experience. Mathematics may well be made the means of presenting this experience, and in itself, by virtue of its being a language in itself, colors and vitalizes experience by grouping it into classifications and laws expressed in mathematical formulas. Again, methods of procedure in mathematics furnish a valuable source of disciplinary training, the identical element being the method of procedure.

Religious efficiency of all the values has perhaps least hope

of realization in mathematics though it is through the treatment of the infinite that one may best get an adequate idea of eternity, of a Supreme Being who has neither beginning nor end.

Domestic efficiency, a field of recent development, would find necessary training in measurement and tabulation, accounts and statistics. Home-making requires a knowledge of dietetics and sanitation—the former a study requiring some mathematical technique, the latter requiring the mathematical controls referred to under the value of health efficiency.

From the foregoing, the reader might easily be led to underestimate the value of mathematics as a method of control of the desired values. This is due partly to the fact that the author in pointing out controls has not considered it within the bounds of time and space in this paper to go into detail, but rather has let the matter go at making general suggestions as to possibilities. Another consideration that operates to leave that impression is the very nature of the function of mathematics. It is rarely a control in itself. It is a tool subject. It furnishes control of certain elements necessary to controls. Its functions variously stated. In substance its function is to acquire proficiency in handling number and space. Rarely do we find the problem of handling number and space a direct control. More often we find it a method of assisting or of making more easy or clear other direct controls. A knowledge of mathematics is fundamental in the sciences. Physics without algebra would be of small value compared to its actual worth, as its quantitative aspect is an essential in its use. The equation in chemistry is elemental. Botany, astronomy, agriculture, zoology, anatomy, bacteriology—all the sciences have been more or less obligated to mathematical controls for the working out of the science, and depend somewhat upon them for a clear understanding and adequate application of their principles and facts.

Architecture, all branches of engineering, medicine, manufacturing, contracting—all put a premium upon mathematical controls. The mistake we make is in assuming that ordinary efficiency in ordinary situations is all that need be provided for and that all else may be left for special training in higher schools. We can not neglect the fact that it is the small margin of efficiency that marks the leader from his followers. The leader, the investigator and pioneer in the field of discovery and develop-

ment often rises from the ranks of those who did not have the opportunity of higher study.

Vocational Guidance.

There arises the question, however: How is the freshman or sophomore in the high school to know whether the calling he is to follow will demand of him any especial mathematical ability? The answer is this. In acquiring the knowledge essential to all in the courses of the first and second year he should find opportunity to estimate somewhat his predilections and would be by the end of, say, two years of mathematics, in a position to know his mathematical aptitudes, abilities, and interests. If he finds that mathematics does not interest him, and is of especial difficulty to him he should know that it probably will not be the wise thing to specialize in the field. If, however, he finds that the field is highly interesting and does not give him any serious difficulty, it is probable that he should go farther into the field and turn his attention towards the vocations that put especial premium upon efficiency in mathematics.

It is not likely that the average boy or girl will discover these things and their conclusions therefrom unaided. In the first place he has not an adequate conception of what constitutes superiority in mathematics, outside of his immediate school group. But more pressing is the need of having some method of coming into the necessary information concerning the vocations themselves. We are guilty of the inconsistency of removing our boys and girls from touch with the vocational life of the world, calculating to aid them, by revealing them to themselves through their studies, to find their most suitable work, leaving them to pick by whatever means, limited, accidental, unreliable, they can, the necessary information of vocational requisites and returns. We have evaded the issue. Vocational guidance is more than an evaluation of the abilities and interests of the child. The other side of the equation, at least, equally important must receive attention. We can not expect boys to secure any adequate conceptions of the things they should know of vocations on the streets or in the home. For instance, the boy excels in his high school mathematics. He feels, rightly, that he should make the most of his gift. He knows that in his relations with the grocer, the element of most importance has been of measures and money. He may straightway erroneously conclude that he will find in that business the fullest opportunities for mathematical ability. The knowledge that the

adolescent acquires concerning vocations is usually very much like the experience of the blind men with the elephant. In fact it approaches a fixed rule that the vocations most attractive to boys of the adolescent period are those which are of least likelihood to prove the most worth while; blind alleys and overcrowded types.

Teachers of mathematics should strive to make themselves sources of information and advice to those of considerable mathematical talent in order that the full possibilities of such may be best conserved and utilized for society and the individual. This should be done by proper educational and vocational guidance. Likewise, those of very limited possibilities in a mathematical way should be directed to other channels as also should those who possess mathematical talent beyond ordinary but who possess other qualities unfitting them for the fields in which mathematical ability is of most value.

Conclusions.

It seems worthy of consideration to the author that:

1. Courses of study and methods of teaching in mathematics cannot continue to look to the theory of formal discipline for justification.
2. They should not look to that theory for a basis of selection and organization.
3. They should not look to college entrance requirements for justification.
4. They should not look to college entrance requirements for a basis of selection or organization.
5. Courses of study and teaching methods in mathematics should be governed in selection and organization by the aims of education and the functions of the high school and should, therefore, be so selected and organized as to contribute directly to common life situations and social values.
6. Mathematics, properly organized and taught, contributes heavily and directly to the important social values.
7. The propaedeutic or preparation function of mathematics is of next importance and is likely to be underestimated.
8. The course of study and methods must also be so selected and organized as to conform to an appeal to adolescent interests, abilities and controls.
9. The possibilities of vocational and educational guidance should not be neglected by the teacher of mathematics.

SECOND LIST OF MARGINAL NOTES ON CAJORI'S HISTORY OF MATHEMATICS.

By G. A. MILLER,
University of Illinois.

In a preceding volume of this journal, Dec. 1919, page 830, the writer gave a brief list of suggested marginal notes on the revised and enlarged second edition of Cajori's *History of Mathematics* in the hope that such a list might prove especially useful to teachers who would make use of this important work in connection with their classes. Having incidentally found a considerable number of additional statements in this work which seem to call for comment the writer offers herewith a second list of such notes with somewhat more details so that this list may be of greater interest to those who do not have on hand the work under consideration.

The fact that these two lists cannot be expected to present a complete collection of desirable comments becomes evident if it is recalled that about two thousand such notes, relating to the largest history of mathematics in the German language, appeared in various numbers of the *Bibliotheca Mathematica*, while these two lists contain scarcely one-tenth of this number. Moreover, the German work is confined to the history of developments in our subject up to the beginning of the nineteenth century while Cajori's work relates to the entire history of this subject. The notation employed in the present list is the same as that used in the preceding list.

Page 4, line 13: "In the Babylonian notation two principles were employed—the additive and multiplicative." Lower on the same page it is correctly stated that some of the Nippur tablets exhibit the *subtractive* principle. The former of these two statements appears also in the old edition of Cajori's *History* and was perhaps in accord with all that was known when this edition was prepared, but it does not convey the correct impression as regards all that was known when the second edition was prepared as results from the added statement noted above. This is an instance of a considerable number of somewhat discordant statements found in the second edition which can be readily explained by referring to the first edition but are otherwise perplexing.

On the same page there appears the statement that "some of the cuneiform numbers found on tablets in the ancient temple

library exceed a million." This is correct but when it is noted that unit fractions of the number 195,955,200,000,000 are found here it is evident that this excess over a million is more considerable than would likely be inferred from the quoted statement. According to H. Wieleitner, *Der Begriff der Zahl*, 1911, page 5, the number 195,955,200,000,000 is probably not the largest which appears on these tablets.

Near the bottom of this same page it is stated that "we possess two Babylonian tablets which exhibit this use," referring to the use of the sexagesimal system of notation. This statement is also found in the old edition, and it represented a fairly accurate statement when the first edition appeared, a quarter of a century ago; but since 1906 a large number of additional tablets containing numbers written in the sexagesimal have beome known, especially through the labors of H. V. Hilprecht, who described over forty such tablets in his *Mathematical, Metrological and Chronological Tablets from the Temple Library of Nippur*, 1906.

Page 5, line 21. In speaking about the Babylonians the following question is asked: "Had they already taken the gigantic step of representing by a symbol the *absence* of units?" It is a question whether the use of a symbol to represent the *absence* of units should be regarded as a gigantic step at the time of the Babylonians. According to H. Wieleitner, *Der Begriff der Zahl*, 1911, page 4, the Egyptians had a hierogliph for zero since the most ancient times. The use of zero as a number with which one can operate is a much more advanced concept than the use of a symbol to indicate the absence of units.

Page 35, line 18. Infinitesimals are not commonly defined as "infinitely small constants."

Page 43, line 4 from bottom. Instead of "found the irrational square roots" read "approximated the square roots."

Page 44, line 15. As Heron is classed with the Greek writers it is not exact to say "this may account for the fact that his writings bear so little resemblance to those of the Greek authors, who considered it degrading the science to apply geometry to surveying." The omission of the comma would tend towards a clearer presentation of the facts.

Page 57, line 3. The statement: "It was indeed a thought of extraordinary boldness, to assume that straight lines could exist, differing from one another not only in length—that is, in quantity—but also in a quality, which, though real, was absolutely invisible," seems too obscure, and the reference to Hankel

does not make it clear. In this reference the words *Mittelalter* and *Alterthum* should be interchanged.

Page 58, line 5. It is here stated that the seventh book of Euclid's *Elements* begins with twenty-one definitions. In *The Thirteen Books of Euclid's Elements*, by T. L. Heath, 1908, volume 2, page 277, there appear twenty-two such definitions. Moreover, Cajori adds that all of these definitions except that for prime numbers are known to have been givenby the Pythagoreans while Heath states on page 294 that the Pythagoreans used the term perfect in another sense, calling 10 a perfect number. On Page 56, Cajori also implies that the Pythagoreans used the term perfect number with its present meaning. It should have been stated that the later Pythagoreans did this but not those belonging to the early period of this school.

Page 60, line 21. Instead of "his age was eighty-four" write "his age at the time of his death was eighty-four."

Page 105, line 22. The sign of division is omitted in the latter fraction, and in the first line of the following paragraph the word "or" appears in place of the word "of."

Page 136, line 13. The word "general" should be added before "equations" in this line and other places in this paragraph. It is known that special equations of every degree can be solved algebraically.

Page 143, line 8 from bottom. The statement "that these proofs would lack rigor was almost to be expected, as long as no distinction was made between algebraical and transcendental numbers," is apt to mislead the reader since the quadrature of the circle by means of the unmarked rules and compass would be impossible even if π were an algebraic number, provided its value could not be found by rational operations and the extraction of a finite number of square roots.

Page 157, line 2. It seems too strong a statement to say that T. Harriot "brought the theory of equations under one comprehensive point of view," as a result of the fact that he recognized the relation between the roots and the coefficients. In fact, Cajori admits in the same paragraph that "he failed to recognize imaginary and even negative roots." A comprehensive point of view of the theory of equations without recognizing such fundamental properties seems impossible.

Page 158, line 10. According to the *Encyclopédie des Sciences Mathématiques*, tome 1, volume 1, page 40, the dot was placed after each number by some writers during the middle ages.

Hence this example does not prove that T. Harriot used the dot to denote multiplication.

Page 167, line 9 from bottom. The fifth perfect number is incorrectly stated here. It should begin with 3 instead of with 2. The same error is found in many other places. Cf. L. E. Dickson, *History of the Theory of Numbers*, 1919, page 13. The ninth perfect number was found by J. Pervusin before it was found by P. Seelhoff, loc. cit. p. 25.

Page 172, line 23. Instead of Simplicio read Simplicius. The former is the Italian form of this name. In other parts of the book the name is correctly given. Cf. pages 22, 23, etc.

Page 181, line 10. According to G. Loria the logarithmic spiral was the first curve to be rectified and hence the statement made here about the semi-cubical parabola is incorrect. Cf. *Johrbuch über die Fortschritte der Mathematik*, volume 28, page 48. The statement that van Heuraet carried the rectification of the hyperbola back to the quadrature of the hyperbola seems also incorrect since the former depends upon an elliptic integral.

Page 182, line 3. The statement that infinite series had been obtained "possibly by others" is quite misleading as may be seen by referring to page 127 and by recalling the use made by Archimedes of such a series.

Page 191, line 10. According to M. Cantor, *Vorlesungen*, vol. 2, 1913, p. 921, infinitesimal calculus was discovered during the half century 1615-1668. Newton and Leibniz discovered *formal* calculus.

Page 209, line 34. Instead of "Berlin" write "Leipzig." In the preceding paragraph derivatives are called differentials.

Page 220, line 5 from bottom. Year of birth of Jakob Bernoulli is here correctly given as 1759 while 1758 appears after his name in the index.

Page 239, line 26. The exponent of 2 should be 2^n instead of $2n$.

Page 250, line 21. The curve whose equation is here given has a very different form from the one determined by the equation in the following line. The latter has three real asymptotes while the witch of Agnesi has only one such asymptote. Hence the statement that P. Fermat gave the former curve in the latter form cannot be correct.

Page 251, line 15 from bottom. These dates are not in complete accord with those found in tome 2, volume 6, of the *Encyclopédie des Sciences Mathméatiques*, beginning with page 1.

Page 254, line 14 from bottom. It is here stated that J. L.

Lagrange proved Fermat's last theorem for the case $n = 4$. On page 239 it is stated that L. Euler proved this theorem. As a matter of fact, a proof of this case is a direct consequence of the propositions that the sum or difference of two biquadrates is never a square, and these propositions were proved earlier.

Page 255. The symbols in the equations near the bottom of this page should be defined.

Page 310, line 2. The term "abbreviated notation" is used here instead of the technical term *abridged notation*, which is used later on the same page. To the names here given as those to whom this notation is due there should be added those of G. Lamè, and J. D. Gergonne. *Encyclopèdie des Sciences Mathèmatiques*, tome 3, volume 1, page 205; volume 3, page 299. Near the end of the first paragraph on this page the word "and" should be replaced by "or" in two instances.

Page 316, line 1 from bottom. Instead of H. B. Baker write H. F. Baker. Add page 1 at the end of this line.

Page 320, line 19 from bottom. This work of Teixeira was translated into French and much enlarged, appearing in two volumes, 1908 and 1909. The first initial of Dupin appearing in line 13 from the bottom should be F instead of E.

Page 356, line 4. In accord with most of the other names which are followed by biographical sketches this name should be Christian Felix Klein. It is interesting to note in this connection that in at least four editions of Ball's *History of Mathematics*, including the fifth edition, 1912, the initials of Klein are given as F. C. in place of C. F.

Page 358, line 2 from bottom. Instead of "only one" write "no."

Page 373, line 4. Instead of "this" write "the preceding." This is another instance where necessary changes were overlooked, as the same sentence appears in the old edition and was correct when that edition was issued. About the middle of the first paragraph there appears the statement that "the first important and strictly rigorous investigation of infinite series was made by K. F. Gauss in connection with the hypergeometric series." On the other hand, according to the *Encyclopédie des Sciences Mathématiques*, tome 1, volume 1, page 170, J. H. Lambert investigated rigorously the infinite series representing $\tan x$. The statement that J. Wallis called this series the hypergeometric series is misleading since Wallis gave this name to an entirely different series which does not involve a variable.

UP-TO-DATE PROBLEMS IN JUNIOR HIGH SCHOOL MATHEMATICS.

By Theodore Lindquist,

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More and more are mathematics principles studied for their applied values. Problems deserve special attention since they constitute the material for the application of the principles.

In the interest of the economy of time it behooves the teacher of mathematics to be continually on the alert as to how much application of any part of the work is necessary. Time is lost by making so few applications of a principle that no lasting impression results just as truly as time is lost by making too many applications of a principle clearly understood by the pupils. For instance, it has been found experimentally that in literal numbers addition and subtraction require little practice compared with multiplication and division. Another waste of time is the neglect of principles and operations, after they have been studied, to such an extent that they are lost sight of by the pupils. Unless principles and operations are used they will soon be forgotten, however well they were once understood. These necessary recurrences may often be arranged for as by-products of other problems. Drills in integers and common fractions can be arranged for in the verification of operations with literal numbers. After pupils have learned to multiply by 25, by annexing two zeros and then dividing by 4, let the teacher arrange to have multiplication by 25 come up often even though it is not provided for in the text used. This method not only gives practice in past operations but makes the pupil feel that each operation must be mastered since he knows he will encounter it later. Problems which require the use of past principles are also the chief aids in unifying the mathematics work of the junior high school, an object much sought after.

Forms of Problems.

First of all there are the exercises and drills as contrasted with the so-called thought problems. Such exercises and drills are essential in fixing the various operations studied. Included in these exercises must be ample practice in the four fundamentals with integers, common fractions, and decimals. The need by all of a facility in these fundamentals, together with the woeful lack too often shown by young people, makes such exercises most necessary. While it is true that the pupils should

have acquired a command of much of this work in fundamentals in the first six grades, still it is imperative that any lack be remedied in the junior high school, especially as many pupils leave school at the completion of the ninth grade. Furthermore, the demand of business for a facility in numerical expressions is a demand which we have no right to ignore.

Much has been written and said of the need of practical problems to most of which all agree heartily. Practical problems must not, however, mean only such as arise out of conditions confronting grown-ups. Not knowing into what walk of life a pupil may be drawn it is impossible to anticipate, except in a general way, the conditions that will confront him later. Hence, problems must be such as will likely come within the range of all after leaving school. For instance, every boy and girl should be acquainted with the elements of banking as carried on in the United States from the standpoint of the person outside but not necessarily inside of the banking counter. Most of us deposit money in banks and withdraw the same but very few of us are employed in a bank.

Good problems must first of all appeal to the pupils' interests. Hence, much material should be drawn from the pupil's own life and activities. Problems based upon child life, which in addition involve applications of mathematical principles and operations that will confront the pupils in the future, are in the truest sense practical. In a certain school the pupils computed the percentage standings of baseball, football, and basket ball teams. Here they found what per cent one number is of another, which involves the same process that they may later need in finding what rate of interest an investment nets. John Dewey maintains that problems "—need not give actual situations to be met with later, but the power to meet them." A happy mixture of problems dealing with child life and others with business will produce the best results. Those of the first class are more applicable to the earlier work in the junior high school while those of the latter class may be increased in number as the work progresses.

Most problems must, of course, be based upon stated data but it will be in the interest of the development of initiative to provide problems that contain no explicit data. "Problems without numbers," in which the pupils state the operations to be used, come within this list. In the junior high school it has been found that the best form is to ask for a statement of the opera-

tion by an equation, which is in the direction of both explicitness and generality. Again it should be mentioned that the best results from these problems can be secured by interspersing them with others rather than by giving them in groups by themselves. Pupils thrive best upon a mixed diet in the matter of problems.

Sources of Problems.

The chief source of problems is, of course, the text. An alert teacher will supplement these from time to time with others based upon local data and conditions. Sometimes the data of the text are merely replaced by local data. At other times wholly new problems may be suggested by those in the text or by some local interests. To secure actual data for all such problems will require too much time from the teacher nor is that necessary. Hypothetical data and conditions may be used providing they appear real to the pupils and are not at variance with actual practice. Freight cars have their capacity in pounds marked upon them as 30,000, 40,000, and so on. Hence a problem referring to a freight car with a capacity of 34,250 would be strained. Heavy loads as wagons or horses are weighed only te within 10 pounds and so the weight of a load of coal must nover be given as 5,716 pounds. It would be quite trite to mention here that all such problems should fit the pupils for whom they are intended as well as the season of the year in which they are to be solved, except for the fact that texts often violate these two primary essentials of good problems. Many teachers preserve all such composed problems in a card file to which additions are continually made. To let the pupils themselves secure the necessary data from questions, observations, readings, or measurements has proved to be a good plan. The radius of a tree can be found by measuring its circumference. The attendance of the classes in the school for a month can be compared from the attendance records of the teachers of the various classes.

Brief historical studies of our number system, of weights and measures, of the organization of some business institutions as banking or insurance, will all be found most interesting and helpful in the correlation of mathematics with other studies. As our civilization is based upon quantitive relations, such studies as these may well be termed introductions to a history of civilization. The interest may be increased by assigning topics to the pupils to be looked up further than the space of the

text permits and reported to the class later. Any attempt at describing the interest shown by the classes in this historical work will fall far short of the actuality.

Carrying out the idea of connecting the pupils' work into a unified whole, problem material may well be selected from their other studies, thus showing the direct application of their mathematics. Contemporary history, civic welfare, elementary science, manual training, and domestic science will supply much excellent material. Sports and other school activities, and home activities are additional fertile fields. Helpful lessons in industry and thrift can also form a part of the problem work. In this connection let us not forget the money value of an education, which ought to be taken up shortly before the pupils are completing the ninth grade, thus giving them an impetus in any desire they may have towards continuing their education in senior high school. It must be recognized at all times, however, that it is the application of mathematics that is sought through these problems and not "run to seed" making up courses in mechanics, applied economics, or the like to take the place of the mathematics course.

As far as possible it is best for a pupil to be acquainted with the complete situations under which a problem arises but that is not altogether necessary. Often much valuable time is lost and the pupils only muddled by explanations of situations in which excellent problem material comes up. In the evaluation of formulas it is preferable to tell a class that a certain formula is used by electrical engineers and then to ask the pupils to evaluate it for certain given quantities than it is to endeavor to give the class an understanding of the formula's particular use. The mere fact that it is a formula actually used by engineers in their work creates the necessary interest. Similar instances are very plentiful.

Mock activities are usually entered into with great enthusiasm giving the work vital interest. As an illustration may be mentioned a school bank. One day the writer observed a junior high school boy decidedly worried because he as receiving teller had accepted a number of checks that had not been properly indorsed.

Let no teacher overlook the valuable number contests in the junior high school. The pupils, especially of the seventh and eight grades, are far from too old to enjoy this form of activity and enter into it enthusiastically. Some form of contest is

particularly recommended for drill work. Before using any number contest it will be well for the teacher to apply to it the tests of a good number contest: (1) It must be simple for the teacher to operate; (2) it must create wholesome rivalry; (3) it must engage the attention of all of the pupils all of the time. Teachers have found it very helpful to divide the pupils of a grade into competing teams which were held permanent for a few weeks. In the first place it tended to create enthusiastic rivalry, but what was far more important, the good pupils on each team coached and gave other encouragement to the poor pupils on their respective teams in order to improve their chances in the contests.

Project-Problems.

An interesting as well as highly instructive process is the formation of problems by the pupils themselves. Project-problems, that are so much discussed at the present, come within this general type. The pupils investigate, as thoroughly as their ages and surroundings permit, some enterprise in which they have become expecially interested. Such an investigation may also, of course, be carried on by some one child of the class alone. Suppose that a class desires to investigate the reasons for the high rents in their community. It is first necessary to decide upon the type of house as to size and location that is to be investigated. The class is next divided into groups for interviewing the real estate agents of the community; this should be planned so that no agent is interviewed by more than one group. In these interviews the pupils ascertain the rents of houses of the general description previously decided upon together with the prices at which such houses could be purchased. After this comes the question of expenses connected with owning a house. This involves visits to insurance agents unless that data were collected during the interviews with the real estate agents. The tax collector must be seen regarding the tax rates and the valuation likely to be placed upon a house similar to the one in question. The estimated expense of up-keep must be secured from property owners or from their agents. Out of the data thus collected the net income is computed, and from this together with the estimated value of the house, the rate of interest such an investment would bring is found. A final investigation would now be to find from the banks and loan agents what would be a fair rate of interest upon money loaned at good security. Hence, the class can decide whether or not rents correspond properly with other expenses.

Seemingly trivial questions or discussions in class may often lead to first-class projects. The above mentioned project might have been the outcome of any problem on rents or the cost of houses. It should be noted that the above project itself suggests a number of others from time to time. The matter of purchase price may start an investigation of the cost of building. This could again be the source for drawing an architect's plan of a house; a study of the buying and manufacture of lumber; the making of contractors' estimates; and so on. The last part of the project opens up the whole field of thrift and investments. A class taught by a former student of the writer has investigated a hypothetical family budget. Each pupil selected his family, which could vary from three to five, together with the income of the family head. From the cost of rent, food, fuel, clothing, insurance, and incidentals, they made out their proposed family budget after reading articles discussing this matter in journals at home or in the library. While this may at first appear to the reader to lack actuality, it did not lack interest in the actual trial nor did it carry with it the undemocratic situation that would have arisen by the use of an actual budget from one or more members of the class. Paper routes, raising chickens, individual and school gardens, pig clubs, corn clubs, the school athletic association, and so on, will furnish much material for project-problems largely in the realm of mathematics. As project-problems depend wholly upon local conditions, it is obvious that texts can furnish only suggestions. A text problem on finding the volume of a city water tank might suggest a project in any city that contains a similar tank. The textbook study of land measure suggests a historical study of the same, a plat of the school grounds, measuring the area of the school grounds, and measuring the area of some other near by tracts. A railroad time table or a railroad map suggests the project of a visit to some interesting city, attendance at a convention, or a visit to a friend.

The simon-pure project springs from the pupil's initiative and that requires abundance of interest. For this reason only such investigations as come well within both the interests and the abilities of the pupils are to be encouraged. A project suitable for a ninth grade class will be oldish to a seventh grade class, nor can this class go into as difficult a project as can the ninth grade class. The above project on rents would be applicable to a ninth grade class. Conversely, a project highly commendable for a seventh grade class will likely appear simple and even

childish to a ninth grade class. In the above suggested list the project on raising chickens which may include building a suitable chicken house, expense of buying the first chickens, expense of feed, expense of increasing egg production, marketing eggs and poultry, the proper keeping of accounts, and so on, would be a suitable project for the seventh and ninth grades. Even though the initiative should come from the pupils, the good teacher, in yet more marked capacity than usual, must be the guiding hand in the background.

If correctly used so as to supplement and to apply the mathematics principles studied, projects can be made exceedingly valuable. They may be a large problem to which attention is given from time to time. The resourceful teacher will find many splendid problems coming up for solution throughout the progress of the project, sort of by-products, as may be noted in the illustration given above. These by-products furnish excellent reviews as they appear naturally and thus take the unprepared pupil unawares just as he will find problems arising in his future life. But valuable as this form of problems may be there is grave danger of overdoing them in the enthusiasm of taking up something that is new and over which much is made at the present.

The big province of junior high school mathematics in the realm of project-problems is not primarily a place for originating and carrying out large projects. Coming back to one of our former fundamental statements, the results of the great majority of investigations must be quantitative to be conclusive and useful, and mathematics will be needed to supply this quantitative conclusion. May we again direct attention to the necessity for a generalized mathematics in the junior high school as project-problems arise along all possible lines of study and endeavor throughout the school? One illustration must suffice. A general science teacher in a junior high school carried out a test of several samples of seed corn. Mathematics was needed in finding what per cent of each sample tested was seed, how far each was above or below a good average, how many bushels were lost per acre according to the previous year's yield in planting each of the poor samples, what this loss was in money per acre, and what the loss would be on a forty or an eighty acre field. The primary function of mathematics in the project-problems of the junior high school is, therefore, to furnish the instruments whereby the results of any investigation are made quantitative, hence, conclusive and useful.

ISSUE SCHOOL BONDS AT TULSA, OKLA.

At a special election held February 17, the voters of Tulsa, Oklahoma, authorized by an overwhelming majority the issuance of $850,000 of school bonds and the increase of the school tax levy to fifteen mills, the maximum allowable under the State Constitution.

This makes a total of $2,850,000 in school bonds authorized by the Tulsa electorate in the last five years. During this period all of the proceeds of the bond issues and a large share of the current revenue of the school system have been used for the purchase of sites, buildings, and equipment.

Since 1915 the scholastic enumeration in Tulsa has increased from 7,526 to 17,501. Fifty new rooms must be added annually to house the growing school population. The voters have never yet refused any request of the Board of Education for funds.

During the last three weeks the Chamber of Commerce, the Trades Council, the various civic organizations, the patron-teachers' associations, and the school children themselves conducted an active campaign of education to assure a large attendance at the polls yesterday.

Much credit is due to Superintendent E. E. Oberholtzer who, in his six years tenure, has established so close a cooperation between the school and the home that an awakened electorate throws its influence almost as a unit in favor of any measure designed to promote the welfare of Tulsa's educational system.

NATIONAL RESEARCH COUNCIL.

The Carnegie Corporation of New York has announced its purpose to give $5,000,000 for the use of the National Academy of Sciences and the National Research Council. It is understood that a portion of the money will be used to erect in Washington a home of suitable architectural dignity for the two beneficiary organizations. The remainder will be placed in the hands of the academy, which enjoys a Federal charter, to be used as a permanent endowment for the National Research Council. This impressive gift is a fitting supplement to Mr. Carnegie's great contributions to science and industry.

The Council is a democratic organization based upon some forty of the great scientific and engineering societies of the country, which elect delegates to its constituent divisions. It is not supported or controlled by the government, differing in this respect from other similar organizations established since the beginning of the war in England, Italy, Japan, Canada, and Australia. It intends, if possible, to achieve in a democracy and by democratic methods the great scientific results which the Germans achieved by autocratic methods in an autocracy while avoiding the obnoxious features of the autocratic regime.

The Council was organized in 1916 as a measure of national preparedness and its efforts during the war were mostly confined to assisting the government in the solution of pressing war-time problems involving scientific investigation. Reorganized since the war on a peace-time footing, it is now attempting to stimulate and promote scientific research in agriculture, medicine, and industry, and in every field of pure science. The war afforded a convincing demonstration of the dependence of modern nations upon scientific achievement, and nothing is more certain than that the United States will ultimately fall behind in its competition with the other great peoples of the world unless there be persistent and energetic effort expended to foster scientific discovery.

HOW DOES THE PRESENT HIGH SCHOOL COURSE IN CHEMISTRY MEET THE DEMANDS OF VOCATIONAL CHEMISTRY?

By Frank B. Wade.

Shortridge High School, Indianapolis, Indiana.

On first inspection of the title of this paper the author was tempted to exclaim, "There's no such thing as vocational chemistry in the high school!" On second thought however it was recalled that we are ourselves at Shortridge High School giving, for the first time this semester, a course in chemistry which is publicly announced as a course in "Vocational Chemistry." This course had its origin about as follows: For many years we have been filling from a dozen to fifteen positions a year with graduates of our one year course in chemistry. These positions have been in the nature of assistantships in practical laboratories in the vicinity of Indianapolis. The boys and girls have become chemists' apprentices or helpers. None of them should be called chemists, although several have shown such ability and application that they have been able to take over the work of college trained men during the absence of the latter during the war. The students that we sent to these places were picked boys and girls in most cases, although frequently our best students were not available to fill such positions as their plans took them immediately to college, which is as it should be. Moreover, it should be noted that it was only a dozen or so who thus obtained employment (nearly thirty last year because of the lack of adult workers on account of the war) from a department that has averaged about two hundred and fifty students during the past few years. Thus only a little more than five per cent of our students have been interested in immediately applying their knowledge of chemistry in a gainful way. Probably a rather larger percent than that have subsequently become chemists or chemical engineers or teachers of chemistry or in some way applied their chemical training after continuing it at colleges or technical schools.

We always strongly urge all pupils for whom we secure positions that they should save their money and go on to college, after a few years in the practical laboratory, if they hope ever to become real chemists, and many of them have done so.

All of this vocational work was done without specific training looking toward the work of the practical laboratory and this fact sheds much light upon the question of our title, for the

[1]Read at the University of Chicago Conference, May, 1919.

course we have been giving seems to have prepared our pupils fairly well for successful service in the practical laboratory.

A glance at the nature of the work now being done by a number of our graduates will show that it would have been folly to have attempted any but general training, so widely diversified are the tasks in the various laboratories to which we send them. One boy is acting as assistant chemist in the Water Company's laboratory. His work is largely biological. While he makes tests of the coal purchased by the company and nitrogen tests and a few other chemical tests such as those for chlorine, for minerals present in the water, etc. most of his work is bacteriological in character. We did not know that that boy was going to that particular laboratory until a few weeks before he was called. I then gave him an intensive course in the kind of work I knew he would have to do, that is, I gave him reference work which would enable him to understand the principles underlying the methods that I knew were in use in that laboratory. The technique I left to the chemist to teach.

Another boy went to a pharmaceutical laboratory where the work is almost entirely connected with organic chemistry and we teach very little of that. Several girls have gone to pharmaceutical laboratories where they have been put to testing hypodermic tablets. Several boys have been working in the laboratories of the local gas company where tests of coals, of gas, of benzol, etc. form their chief tasks. A large local engine works employs several of our graduates. The work there is mainly volumetric analysis of steels. One boy went to a rubber laboratory another to the Presto Lite Company. It can be readily seen that no course could be devised that would prepare all of these pupils for the specific work that they are called upon to do.

In a city with one preponderating industry employing numbers of pupils some such course might perhaps be planned but even then it may be doubted if it would be advisable. Practical methods change rapidly. The teaching of the industrial laboratory, where time is money and efficiency is a fetish, is bound to be more intensive, and effective in regard to specific method and routine than the more leisurely teaching of the schools.

There is no time in the one year high school course for specific training, in fact there is not enough time to teach thoroughly the underlying principles and theories of general inorganic chemistry. The practical laboratory certainly is no place to acquire these fundamentals. If the pupil does not get them in school he will probably never get them. Hence I say let the practical

laboratory teach specific methods and let the school prepare the student to be a rapid and intelligent learner, one who will want to know the why as well as the what of the routine methods of the laboratory to which he goes and one who will find out the why sooner or later with the help of the man over him. Such a student will be more likely to be advanced in the laboratory than one who merely does his day's work unthinkingly.

Now those of my hearers who have been reading between the lines of my subject matter can readily see why I was prompted to exclaim, "There's no such thing as vocational chemistry in the high school!" and yet you may be moved to demand, "Then why in the name of common sense are you offering such a course?"

Softly, softly, it's easier to fool a corporation than it is to fight it. Don't you know *vocational everything* is *the thing* just now? We must have it! So we offer it—but to whom and how? Only to pupils who have first made good use of the opportunities offered them in a thirty-eight weeks course of ten periods per week in general chemistry. To be admitted to Chemistry III as we call it, the recommendations of his chemistry teachers and of the head of department must be had by the candidate. He must also either have definitely in mind the use of his chemical training in a gainful way or else he must be intending to pursue chemistry in college. In the latter case the principal advantage to the pupil will lie in the opportunity that is afforded to apply and to keep freshly in mind some of the chemistry that he has already learned. We caution our candidates not to expect advanced standing in college on account of their work in Chemistry III.

At present we have some sixteen pupils, boys and girls, in Chemistry III. About half of them expect to go at once to college.

If I have dwelt at length on this vocational course of ours it is because, in planning it we were forced to think out an answer to the question that your chairman gave me to discuss. Our problem was of course, what shall we teach these boys and girls that they have not already got in their year of general chemistry? Through the author's memberships in the American Chemical Society, the Indiana Academy of Science and the Scientech Club of Indiana he was able to go to many college men and to many practical chemists for advice.

In reply to my question as to what we should teach the boys and girls whom we would send them in the future, the practical men without exception gave answers such as these: 1. "Teach them to have respect for figures, to be honest with their data,

never to 'doctor' their results." 2. "If you can teach them in three months to clean their glassware you can do better than we can in the laboratory." 3. "Teach them rapid and delicate manipulation of apparatus." 4. "Teach them to use the analytic balance rapidly and accurately and to read graduated measuring tubes and flasks etc." 5. "Teach them to think chemically, we'll teach them the specific routine after we get them in the laboratory."

It will be recognized that very little specific content of the course was suggested by these men who have been employing our pupils. With the exception of the request that we teach the use of the analytic balance and of graduated glassware the replies were all of a general nature. Our effort in our first year chemistry has always been to impress upon our pupils the things these men ask of those whom they employ and the degree of success that we have already enjoyed, as evidenced by the increasing calls for more graduates from the chemists who have used our boys and girls, would indicate that "the present high school course in chemistry" as given by us and by all forward looking institutions of like nature fairly well meets such demands as come to us from the real chemist who seeks a helper in his laboratory.

In closing you may be curious to know what sort of specific content we are using in our Chemistry III course. It is in the main an elementary course in volumetric quantitative analysis. We chose this material because it affords fine opportunities to apply chemistry that has already been learned by our pupils in their first year course. In making up and standardizing their own solutions they have an opportunity for considerable use of the analytical balance, they get splendid practice in the use of graduated glassware, there are many calculations from equations to be done, which reviews their stoichiometry, and they encounter very little chemistry which calls for prerequisites that they have not had. While qualitative analysis should properly precede quantitative analysis in formal courses of study there is really very little use made of qualitative results in simple volumetric work such as acidimetry and alkalimetry, oxidation and reduction titrations and iodimetry. Such reactions as the pupils are unfamiliar with can be studied as need arises and calculations can then be based upon them.

In conclusion, the author is still of the opinion that *there isn't any such thing*, although he may be like the old lady about whom the old gentleman said, misquoting Scripture, "As a woman thinketh so is she and don't you forget it."

THE ROLE OF LABORATORY WORK IN GENERAL SCIENCE AND THE TEACHER TRAINING IT INVOLVES.[1]

By Herbert Brownell, B. S.,

Professor of Science in Secondary Education, Teachers College, University of Nebraska, Lincoln, Nebraska.

Ladies and Gentlemen of the General Science Section:—No apology is necessary, so I am assured, for appearing before you *with a paper to be read.* Nevertheless, it may be well to "explain" that by so doing you can rest assured that in due time—say in thirty or thirty-five minutes—I will at least have reached the end of my paper. So complex are the relationships in any consideration of what characterizes a laboratory basis for the teaching of general science, and so difficult is a discussion of the problem of providing suitably trained teachers to make this work a success, that without the limitation of a manuscript the temptation to unduly prolong the discussion might prove irresistible.

In the period of world upheaval from which we are so slowly emerging, the American public under stress of necessity has become familiar with many and diverse sorts of "substitutes." In the recent sugar shortage there was a near-rebellion in my family over the use of syrup on breakfast foods. Not one of us would allow that there is any substitute for cane sugar. In twenty-six years of training science teachers for secondary schools, I have been unable ever to find any satisfactory substitute for the laboratory in science teaching. The same is true, too, for my methods courses for teachers of general science, youngest of the high school science subjects.

We all have heard of the man who finally succeeded in getting his old horse to live without eating only to have the "critter" die on his hands. I am convinced that without laboratory work of an appropriate kind general science, too, will die! And unswerving as my advocacy has been for years of the claims of general science for a place in the curriculum of the high school, if it be a text subject only, and is to remain that, then in my opinion it deserves to die. In this connection let me say, however, that my notion of what is properly included under the term laboratory work in high school sciences, especially in such a subject as general science, may not be considered wholly orthodox by all science teachers.

[1]Given before the General Science Section of the Central Association of Science and Mathematics Teachers, Chicago, November 29, 1919.

You to whom I have the great pleasure of speaking today in this discussion of the teaching of general science *as a laboratory subject,* are able, by reason of your positions and standing in the educational world, to exert a powerful influence upon what eventually shall be the manner in which general science is taught. As I view the question of laboratory exercises in general science, it is not so much a matter of any set form of procedure, or of any specified list of exercises, as it is a question of the spirit and general educational purpose involved.

It has long been my belief that aid of a helpful sort is continued to my students during their first teaching experiences in their own schools through use by them in the different sciences of certain carefully prepared manuals as *Laboratory Lessons.* These contain matter supposedly suited to high school classes, especially those of the smaller high schools, and are so arranged that much of the instruction of the course as a whole centers in and can be grouped about simple inductive laboratory exercises. These exercises seek to provoke and direct the thought of pupils progressively toward the several teaching ends in view in every lesson. They are not exclusively experimental, but often consist of sets of prepared questions, of required drawings and descriptions, of various problems and other quantitative exercises. With increasing experience on the part of the teacher, he is expected in due time to become more and more independent of these aids, and able to select matter and organize a laboratory presentation of it in ways more or less original and suited to the instructor and to his teaching conditions. Because of this belief in the worth of laboratory manuals to teachers generally, and believing as I do that manuals are indispensable to those inexperienced in laboratory instruction in high school sciences, I beg your indulgence as I quote in substance only, and somewhat briefly, from an article which appeared in the June number of SCHOOL SCIENCE AND MATHEMATICS under the title, "The Laboratory Manual—Its Purpose and Contents":—

In visions of what in general shall characterize this best-of-all manuals, certain outstanding features have gradually taken shape.

In the first place, any such manual lends itself to a conception of the laboratory hour *as a study period.* During laboratory time under guidance of the instructor there is possible a methodical and sustained training of pupils day by day in ways of

acquiring knowledge which are characteristically scientific, and at the same time not exclusively experimental.

In the second place, before any experiments are worked by pupils, this manual provides that there shall be assembled through questioning, whatever knowledge the pupils possess of the topic under consideration, and that this knowledge be organized around the results of a certain small amount of experimental work *done by the teacher*. Obviously, these experiments must be simple, and so chosen that a scientific understanding is secured both of the old and of the newly acquired knowledge. The experiments are designed to arouse and sustain interest, provoke thought, and become centers of new groupings of knowledge. Whether such preliminary discussion requires one period or two, and whether or not it be completed during one day's session, is of far less importance than are the teaching values attained in the time spent in the discussion. To hurry the presentation of scientific fact and theory upon pupils mentally unprepared to receive it, and indifferent because of this unpreparedness, is to defeat the purpose which prompted the haste.

It is both the province and the opportunity of the instructor during this time of introductory discussion to guide it in such ways and to so enrich its content that time spent upon it *constitutes a teaching period of largest possibilities.*

To interpret simply and effectively the many unrelated experiences of pupils, the instructor must be prepared to contribute a large measure of additional information to the end that what is known by the pupils shall have scientific organization and significance. Each succeeding phase in the discussion of any problem then acquires its correct bearings and scientific relationships.

During the time spent in the laboratory in writing up the results of exercises worked out, and in answering questions raised in connection with these exercises, need arises for use by the pupils of texts and reference books in order to satisfy every desire for knowledge more definite and more complete. Here is the time of all times for a training in the right use of the text as a book of reference. There is great educational gain in thus stimulating and establishing that habitual attitude in pupils which leads them to discern clearly just what information is needed, and which directs them in the ways of acquiring this knowledge *at the very time when it is most serviceable to them.* Such training as this "carries over" from school days into all

the varied activities of later years. This combined use of books and experimental exercises in teaching secondary school science is far more productive than is their separate and more or less unrelated use.

Certain questions, too, are to be provided in this manual. These seek to anticipate difficulties likely to be experienced later in the text assignments, questions which necessitate a discriminating use of text and reference books in a search for information of a specific character. Such requirements lessen the time spent later by pupils as text preparation for "recitations," for "quizzes," and for "examinations," since some of the more extended discussions of the text thus have been disposed of.

In so far as there is a simple experimental basis for it, the manual fittingly appropriates to its introductory discussions portions, too, of the theories of science. There is little likelihood in any such procedure of a failure to leave for subsequent text discussions sufficient difficulties to tax fully both teacher and pupils.

It has been my desire in making as above these rather free quotations from the article in question to emphasize strongly a personal belief that the teaching of elementary science measures up to its possibilities only as its laboratory exercises *are correlating centers for all phases of the teaching process*. This belief amounts to a conviction—a conviction based upon many years of testing in my own work, and upon results known to have been wrought out in teaching done by others. Especially do these beliefs apply in the teaching of general science. As a science subject, taught without well defined and well sustained laboratory features, general science fails to function properly in public school education.

The laboratory manual should direct a teaching procedure in which instruction is combined with an experimental presentation of the topic studied. These features must be so inextricably interwoven that teachers inexperienced and ill-prepared cannot go far astray in their teaching, and then only after much the same degree of difficulty experienced by the Senators at Washington in disentangling the League Covenant from the Treaty of Peace.

Do not misunderstand me! You to whom I am speaking may be wholly independent of any need to follow laboratory manuals as published unless it be as time savers in laboratory adminis-

tration. Trained science teachers of long experience in large city systems can well be left to choose and combine and use successfully material of their own for science courses. Their laboratory problems are of a different nature. But let it not be that we who are earnest advocates of the worth and excellence of general science in high schools be blind to the fact that the future of this subject as an integral part of public school courses is largely in the hands of high school teachers lacking your experience and fitness for teaching—teachers to whom the role of effective laboratory work in elementary science teaching is yet a matter of discussion rather than of performance. Relatively ve y few high schools employ special teachers for the different science subjects. In many of the smaller high schools the untrained unprepared "science teacher" faces teaching conditions suitably characterized as "impossible."

We are not altogether hopeless of the coming of a time when general science shall be taught by those only who are especially prepared to do it, and who have the all-round teaching skill so necessary to meet successfully its teaching difficulties. But we have to confess that to our certain knowledge there are yet many things in connection with science in the public schools over which we as science teachers lack control, not least of which is power to say *who shall not teach science in high schools.* As a matter vital to the future of general science, its advocates can insist that its teaching on any basis other than laboratory exercises is to invite failure generally with promise of success only when in the hands of the relatively few exceptionally capable teachers, those likely to succeed in the teaching of any subject. The instruction given should follow such a procedure that the average teacher in the smaller high schools need not make a failure of general science, but rather make a great success of it. There is need of a manual calculated to serve general educational ends as well as the special purposes of a scientific presentation of topics included in a course in general science. Publishers will, I believe, be glad to provide such manuals when any considerable demand for them is voiced. The problem under discussion is made doubly difficult by the fact that in the small high schools there is an endless round of changes in the teaching force, and teaching efficiency *through experience* is little in evidence.

For seven years now I have been giving in the Teachers College of the University of Nebraska "methods courses" in general science, repeated the first and second semesters and in summer

session. These classes of prospective teachers have averaged twelve or more, but there is no sufficient reason for believing that these students with this limited special preparation have all taught general science. It is reasonably certain that few of them have continued as "science teachers" through many years. The School Directory issued by the State Superintendent of Nebraska for the year 1918-19 names 380 high schools employing four or more teachers. Of these 250, or 65 per cent of them, reported to the office of the Inspector of Accredited High Schools courses given in general science. This means that *in seven years' time* I have had about as many students in my two hours' methods course in general science (241) as there are schools in which the subject is being taught. Now I do not flatter myself that any school board has waited seven years in order to get one of these teachers. The total number per year of prospective teachers of general science from all the teacher training agencies of the state is pitifully inadequate to meet the needs of the public school system.

Speaking in general terms, and without data to verify the statement, the common procedure in general science as taught in high schools is to require pupils "to recite" upon text assignments, with laboratory work lacking entirely, or merely incidental and spasmodic in character. It seems safe to assume from knowledge at hand that a large majority of those teaching general science in the smaller high schools have neither had any sufficient preparation for this very difficult teaching, nor do they intend to continue teaching the subject and thus become proficient through practice. In many cases, so I have reason to know, general science is assigned to a teacher in spite of her protests of unfitness to give instruction in it, and of an unwillingness to undertake it. The subjects of the curriculum are "divided up" among the members of the teaching force, and the person making least protest gets general science. I have more than a suspicion that similar conditions may be found elsewhere than in Nebraska, possibly in the communities and states from which some of you come. Wherever such conditions are found, there is warrant for a note of alarm over the future of general science. There may come a time when advocates of this subject will be called upon to show cause why it shall not be dropped from the curriculum of the high school owing to lack in educational values attained. The introduction of general science into the high schools of the country has been so rapid as to be a joy to its

advocates. It may be it would have been as well if its introduction had been slower. If reasonably well taught, its permanence in high school courses is assured. But continued lack of any laboratory basis for instruction in it, and lack of teachers sufficiently well prepared to give this instruction, may even yet turn the tide against it.

It can be taken for granted that teaching success in the sciences as in other high school subjects involves an ability on the part of the teacher to secure well sustained efforts on the part of pupils in satisfying the normal human desire to learn *whatever is worth knowing.* The greatest of all teaching difficulties encountered in the elementary aspects of the sciences does not inhere in the subject matter, but lies in the "human element" involved in the teaching process—lies in the boys and girls under instruction who all too often are indifferent and sometimes antagonistic to a teacher's efforts. Advocates of general science have won for the subject a permanent place in the high school curriculum *on the ground that it is based upon broadly educational rather than strictly scientific lines.* While inevitably it is introductory to later courses in the differentiated sciences of the high school, such is not its chief purpose. Whatever is of largest educational advantage to the boys and girls under instruction, providing it is germane to discussions of the phenomena of natural science, dominates all other considerations. The selection of matter, and the manner of its presentation, should take into account first and all the time the intellectual fitness of pupils as the men and women of tomorrow. Here, too, is ample warrant for an enrichment of its discussions by consideration of the applications of science to social and economic welfare. And we take occasion right here to express the hope that the time may never come when this course of the secondary school curriculum shall lose the flexibility it now has, and teachers their freedom to adjust its matter and method to fit widely varied teaching conditions.

Any discussion of our subject restricted to the two items (1) a supply of suitably prepared teachers for general science, and (2) their presentation of the subject upon a laboratory basis, is incomplete. For it is shortsighted ever to expect in the smaller high schools of the country teachers trained for general science alone. Nor would this be desirable. While in teachers colleges and in normal schools there properly is a "special methods" course in general science, the preparation of teachers for this

subject should by all means include at least enough of the elementary phases of other high school sciences so that in the smaller high schools the teacher of general science is the "science" teacher in the corps of instructors. Preparation for this teaching of "high school science" should be extensive rather than intensive, making any suitable preparation of science teachers for small high schools especially difficult.

In the aggregate a large number of young men and young women who have been in my classes have later taught science in the high schools of Nebraska, and in adjoining states. The teaching conditions encountered by them in the various schools, and the various factors personal and otherwise likely to determine their success or failure, have been matter of inquiry, of observation and of personal concern. The needs of the smaller high schools for closely correlated science courses effectively taught, and the apitude manifested by those anxious to qualify for this teaching, have ever furnished me an incentive for sustained efforts through many years in seeking a greater teaching efficiency in the high school sciences.

During these years of my teacher training experience, profound changes have occurred in the character of science teaching in the schools of Nebraska as elsewhere the country over. There has been great increase in the number of high schools, in the number of science teachers needed in them, in the extent of laboratory courses, and in the equipment for such courses[2]. The aims of high school science teaching have undergone great changes, too. No longer is one who has "specialized" in some one of the sciences, *e. g.*, in chemistry or in physics, considered as sufficiently fitted thereby to meet the varied demands made upon him *as the science teacher in a small high school.* Demands made by school boards often amount to an unqualified insistence for teachers who possess general knowledge in all the fields of science, a knowledge which though elementary is definite, unified rather than differentiated, and closely related to the social and economic life interests of the pupils taught. The demand is for ability to aid high school boys and girls to acquire such understanding of the phenomena of their natural environment as develops in them an habitual attitude characteristically scientific.

Whatever money can buy in the way of furnishings, books, etc., is available in these days in almost every community for use by science teachers of proved competency. But so far as the

[2] "The High School Situation": Woodhull, in *General Science Quarterly* of March, 1917.

smaller high schools are concerned, teachers of high ideals and large aptitude, and who at the same time are masters of the purposes and procedure of laboratory science suited to beginners, would seem lamentably scarce in our American public schools. This in no sense warrants any relaxation in effort for meeting the needs of these schools in every way possible, nor does it justify a return to the discarded plan of attempting to meet these needs by certification of those who have specialized in some one science, and then have added to this academic preparation a few "courses in education." Bitter educational experience has taught the futility of this solution of the problem of providing science teachers for the smaller high schools.

Throughout this discussion which now must be drawn rapidly to a close, I have purposely avoided consideration of the peculiar problems confronting teachers of general science in the large high schools where sections of maximum enrollment occupy all the time and resources of special teachers. Despite the amazing total of pupils in the large high schools of the country, and the necessary modifications in procedure to handle the crowded classes in general science in these schools, there is at least some large degree of permanency in the teaching force of such schools. But failure here to teach general science upon a laboratory basis, whether of the standard type of such special sciences as physics and botany and chemistry, or the greatly modified and simple procedure suggested above in connection with the characterization of laboratory manuals, invites the same condemnation and rejection of general science in the curriculum of the large high school as in the smaller one. Whether or not experiments are performed exclusively by the instructor as each topic is taken up in turn, and what ever may be the combination of experimental work, discussion, study, and written efforts, it is possible for teachers of general science in large high schools as in small to develop, to direct, and to habituate pupils to the spirit and procedure of laboratory sciences. The worth of this training easily transcends the informational values of the course, however great these may be.

We who are especially concerned with the future of general science can well afford to unify our aims in our various fields of endeavor, though our procedure in attaining them may have little in common. Diversity in method is wholly compatible with unity in aim, and nowhere in school work more so than in general science.

And now in closing may I say that I am ever impressed with the sanity of a demand that he who theorizes in education, and who undertakes to formulate its principles or to present for consideration any philosophy of education, may very justly be required at the same time to specify by what course of action this theoretical shall become practical, establishing his right to a hearing by reason of evidence of success in an application of his beliefs. That architect alone is great whose visions take form in drawings, plans and specifications, and eventually in enduring structures of stone and steel. My belief based on experience is that the views presented in connection with this discussion of the "Role of the Laboratory in Teaching General Science" will stand the test of application. Too much of enduring value has been hard won for general science in the field of public education to warrant risking loss of what has been won. Can we not unite in insisting that in all general science teaching there shall be the spirit, the procedure, and the values of experimental science?

FEDERAL AID TO SOLDIERS.

In almost every community in the United States there is a discharged soldier, sailor, marine, or war nurse, suffering from some injury or ailment which dates back to service with the fighting forces.

Often this injury or ailment has made it hard or impossible for them to fit in where they did formerly. They are handicapped and need help; not charity, but mental and physical reconstruction. In many cases such people unfortunately keep their troubles to themselves. They are reluctant to seek aid or advice, for fear their friends might consider them weak. Possibly you know such a person.

If you do, encourage him to take his troubles to the Government. The War Risk Insurance Bureau and the United States Public Health Service are especially anxious to get in touch with such individuals. The Public Health Service has set up a chain of reconstruction bases throughout the country for beneficiaries of the War Risk Bureau. These are not army hospitals, nor is there army discipline in connection with them, but rather a system of hospitals similar to the general hospital in large cities except that the treatment is free and goes much further than in the ordinary hospital.

Recreation, vocational training, and wholesome entertainment are combined with treatment. While men are being bodily rebuilt they have the opportunity of learning some useful occupation, or pursuing academic studies. They are taught not only to find themselves, but to better their condition. The environment is as homelike as it is possible to make it.

A great many men who went into the army have developed tuberculosis and other diseases requiring special treatment. The Public Health Service has separate hospitals and sanatoriums for these patients, where they may get the best treatment known to medical science.

A large number of soldiers are not yet aware that the Government offers them free treatment. Please tell them.

POSSIBILITIES OF HOME WORK IN GENERAL SCIENCE.[1]

By Prof. G. A. Bowden,

University School, Cincinnati, Ohio.

A few months ago while conversing with a teacher of English in a large city high school, I learned that she had directed her pupils to write a description of the domestic house cat from first-hand information gained from the living subject. The following day the students apologized for not having prepared the descriptive theme according to the instructions given, because, after due search and diligent inquiry had been made, they had failed to locate this species of animal. The intent of this teacher of English was grand, life descriptions must be made from living subjects, but she failed to get such descriptions from her pupils for the very reason that she is living behind the time and advancement of our modern age. She should have known that in all well regulated city homes the cat has been strictly replaced by the simple spring mouse trap in much the same manner that the horse has been driven from our city streets by the automobile and auto truck. Furthermore she should have known that the pet of her maiden youth has become very unpopular as a carrier of disease, an element in the high cost of living, and in the teachings of Audubon societies, and for these reasons her pet in memory has been outlawed and consequently not commonly found in a well established and up-to-date community.

But what do you actually think of a teacher of general science who taught the construction and operation of a hot air furnace in the space of fifteen minutes, and who on the following day sprung a twenty minute quiz on his pupils to test their understanding of this heating and ventilating device? The teacher of English who desired a life description of the recently ancient cat is an artist and an up-to-the-minute teacher compared with him. Her pupils did at least discover the scarcity of cats. What did his discover? Did they really discover that a hot air furnace has an actual existence and a relationship in and with a fairly modern home? She had at least an actual project in mind and had sent her pupils forth on a happy quest to search and to learn from first-hand experiences, but his went forth from a room actually ventilated with confusions and abstractions to return the following day to a bondage of classroom despotism

[1]Read before the General Science Section of the Central Association of Science and Mathematics Teachers at Lake View High School, Chicago, November 29, 1919.

to be examined on a superficial nothingness which, happily, was no part of them. I know that you are thinking that these illustrations are far- and over-drawn; perhaps they are, but they illustrate well the purpose of this paper.

The possibilities of home work during a course in general science depends wholly upon the attitude of the teacher who is handling the subject. If the course is limited to the mere dimensions of the classroom or laboratory of the particular building in which the teacher is offering instruction, there are no possibilities for home work in his general science course. On the other hand if the teacher realizes that of all the subjects offered today in our courses of secondary education that general science is the one subject that deals with the translation of the physical elements that make up the home and community life of man he will find that there is abundant opportunity for a great deal of delightful and inspirational teaching which will send his pupils back into the home and community eager to experience and give expression to the elements and factors of their very lives that existed heretofore deep in the substratum of their consciousness. Failing to receive this directional teaching a child's subconscious mind becomes a veritable grave-yard of ideas and thoughts that might have found an expression in a living consciousness instead of passing into an accepted oblivion in which there is no analysis into "the why of things."

To insure the success of this kind of work in the classroom and in the home the teacher must necessarily survey the "stock in store" of the average individual pupil that confronts him. He must acquaint himself with the amount and kind of nature study work, geography, physiology, elementary agriculture, manual training, and other elementary sciences and arts that have been taught to the child while climbing up through the grades. For today a lot of wholesome work is being done in these pre-elementary sciences of the grades, and this work bears much the same relationship to the general science course that the sciences of the high school period bear to the early sciences of our universities and colleges. He must study the community in which the child has been reared and catalogue, so to speak, the experiences and daily phenomena with which the child is already acquainted in a more or less superficial way. Having made these surveys and catalogues of the elements and factors that make up "the stock in store" of his pupil, the teacher must determine upon a course of projects which will lead his pupil

into "the heart of things," a course of projects that are in themselves related and capable of an easy classification; a course of projects that leads the child's mind more or less consciously to see the relationship of things and events from the standpoint of cause and effect; a course of projects that aims to develop an attitude of observation that leads to conclusion of fact and principle.

In an endeavor to embody this spirit and mode of presentation in our general science course in the University School at Cincinnati we have built the course about the following series of projects:

1. Lighting the home.
2. Heating the home.
3. Weather and climatic conditions about the home.
4. Building the home.
5. Clothing and feeding the individual of the home.
6. Communicating with the home.
7. The home and its relationship to the world's work.
8. Life and self improvement.

As you at once observe, we have emphasized the home element throughout the series of projects. The common criticism is that such a selection of projects narrows the field of general science, but such is not the case, and quite the contrary is true. Here, at least, we have no series of subjects on certain portions of chemistry, physics, biology, astronomy, earth science, physical geography, and physiology which have no relationship other than the buckram that binds the text in which such an arrangement is presented.

What does the first project, lighting the home, suggest to you? In order to develop this project we are led to take up the following sub-projects which present themselves at once in a natural sequence: the discovery of fire and with it the primitive uses of heat and light; various primitive lighting methods such as the firebrands and the vessels of burning oil with and without wicks; the development of the candle; kerosene and the kerosene lamp; gasoline and the gasoline lamp and its need of a mantle; illuminating gas and gas lighting with its two types of lamp. jet and mantle; electric energy and the development of the filament and arc lamps; natural and artificial lighting; and direct and indirect lighting systems. These sub-projects, of course, suggest subsidiary projects and problems to which attention is necessarily called during the process of its development, and thus we see that each project becomes automatically a center of logical organization.

The project method of attack makes home work a possibility for the very reason that it incites the pupil to action rather than to inaction and reaction. Let us consider the project of lighting our home and here discuss a mode of attack or presentation for the first sub-project, the discovery of fire and its primitive uses. The actual discussion between teacher and pupil arises from the following considerations:

Was primitive man ever without fire?
How did he at first obtain fire?
Did he later learn to produce fire?
What were the methods of producing fire?
Did the American Indian use any of these methods for the production of fire?
How did the Pilgrim start his fires?
Have you ever started a fire by any of these methods?
Will you try and see if you can succeed?
Will you bring to class the articles and materials which you used in trying to produce fire whether you succeeded or whether you failed?
What effect did the discovery of fire have upon the life of primitive man?
Did he light his home?
Did he have a portable light?
Will you prepare some firebrands and bring to the class?
Have you ever seen a picture of a Greek or a Roman lamp?
Describe its shape.
Can you name the materials of which it was made?
Name the oils used in these Greek or Roman lamps.
Why did they use a wick in these lamps?
What materials were used in manufacturing the wick?
Will you make such a lamp out of modeling clay and bring it to class ready for use?

Here we have the pupil and teacher on a common ground but viewing the situation from different points of view; the pupil supplying the bits of information that he has already picked up, and the teacher adding information that will direct the pupil into channels that furnish a more definite and clarifying understanding of the question in hand.

Of course some assignments must be made. I have found the boys ready and willing to try out the methods of producing fire, while the girls will take the easier task of producing the firebrands and clay models of the Greek and Roman lamps. And also as a matter of aid we have the modeling clay on hand ready for distribution. And right here let it be said that the teacher is to be more than reasonable in his demands for this kind of home study and home work. Never attempt or demand the impossible by asking the pupil to work with materials or instruments which he has not readily at hand. For example, should the teacher ask the pupil to make a study of temperatures in the various parts of the home refrigerator, this task is at once impossible for those pupils who have no thermometers. Have

your thermometers ready packed in strong cases ready to loan for such home work. The pupil borrows valuable books from the library for home work. Why not some of the hallowed things of the laboratory? Do you not think that he will take a pride in explaining and setting forth his knowledge of the thing in hand to his father, his mother, or immediate relatives and friends? Do you not think that his bit of private intimacy with the thermometer, electric bell, or whatever it may be, will not result in the best kind of self improvement and soundness of understanding?

Now what are we to do the next day when the pupils present themselves with firebrands, fire making apparatus, and Greek and Roman lamps? The first matter of importance is that each pupil be given an opportunity to exhibit before the class the apparatus or materials with which he has worked, giving in his own manner the reason for selecting the materials and explaining the method of successful operation. If the pupil has failed to get the results for which he has worked, he is to explain the cause of failure from his point of view. This attitude of mind that discovers the reasons for failure is of the greatest importance and is one of the elements of mind training and character building that is to be emphasized throughout the course. After each pupil has reported his efforts comes the class demonstration. The successful fire makers are to come before the class and operate their various implements in a contest for the production of fire. The remainder of the class are being acquainted with the various primitive methods and the relative merits of each. Of course these primitive tools are in inexperienced hands, and the performance of the operation may not be that of the expert, but the performing individual and the observing individual are receiving better concepts than teacher or book can ever impart. Next the firebrands and the Greek and Roman lamps are put into operation by the pupils who brought them, and various points of comparison and contrast are pointed out and emphasized. After the pupils have made their recitations and demonstrations, it becomes the teacher's part to develop those parts of the lesson which thus far have not been given full and proper expression by the pupil. In this lesson it is quite certain that the pupil will tell you that he rubbed the sticks together to produce fire or heat; it is the teacher's function to develop terms, definitions, and generalizations closely allied with this very act, such as *"friction," "friction results in heat," "kindling*

temperature"; the girl who brought in the Roman lamp will surely tell you that the wick is for the purpose of conducting or leading the oil up to the flame; it is now the teacher's mission to develop the term "*capillary attraction.*" And so it goes throughout the entire course of projects, the pupil gathering together the concrete expressions, seeking for causes and effects in so far as he is able, and then the teacher stepping in as an assistant to help with the defining, abstracting and generalizing of the question under consideration.

As man progressed in his civilization his habits became more and more complicated, and since the projects enumerated above are taken somewhat in the order of their historical development, we shall find that the presentation of the project becomes degree by degree more and more complicated. It is the business of the general science teacher to design and arrange his projects in such a manner as to direct the pupil through this labyrinth of human problems. Now it would not do to develop all the projects in exactly the same style and manner as we did those for the production of fire, firebrands and Greek and Roman lamps. The plan of attack and the program suggesting the order of action must be varied with each type of project. These changes and variation of method in the handling of the project plan are imperative, if the teacher desires to develop a pupil who at the conclusion of the course shall be prepared and equipped with a mental attitude of doing things and reasoning out the solution of problems for himself.

Consequently, when we take up the candle as our next project in the lighting of the home, we vary our method of attack and assignment for the home work. Here Michael Faraday in his *Chemical History of a Candle* has fully developed for us the best possible method of presentation, and the teacher can do no better than to follow step by step the methods therein suggested and assign as library or home reading definite portions of this wonderful classic. Instruct the class to make at home a dip candle as suggested by Faraday, using paraffin in the place of tallow. Tell them to experiment with the candle in the same manner as Faraday did and to observe all the phenomena that he calls to their attention. (Here it is necessary to give to each pupil an ounce of paraffin, a short piece of glass tubing with fire polished ends, and a piece of fresh lime with directions for making and using lime water.) You teachers who have never read Michael Faraday's *Chemical History of the Candle* are not

in position to grasp the importance of this kind of assignment. Michael Faraday lived in the days of candle lighting, in the days when the candle was a household necessity, and therefore was able to write from a standpoint of actuality that fairly radiates, and the teacher of sciences who fails or neglects to call these spirits of the past to aid him in presenting his subject fails in the development of refined tastes, or powers of appreciation, and mental growth.

The pupils are again before us after spending an afternoon or evening with Michael Faraday and his candle. Again as before each pupil is called upon to relate his particular experiences, observations and conclusions. As the conference hour proceeds each succeeding pupil should be urged to present the matter with greater care of order and detail. The teacher who appreciates the value of scientific exposition, though expressed in a narrative manner by the pupil, will find that the majority of his pupils have acquired through their own effort a conscious order of things and facts. This is the kind of training desired, habits of mental activity that are orderly—orderly without too much effort that labors for order. True some of his pupils will show a chaotic condition of mental processes while rendering the recital of the observations and interpretations of their personal experiences, and so here again it is the mission of the science teacher, like a Faraday, to point the way with patient indulgence. Then it is the teacher's business to give suggestion or question. The question or suggestion must drive straight to the heart of the subject under consideration. For the above project we may suggest or question as follows:

Did Michael Faraday talk about capillary attraction?
Did Michael Faraday give other illustrations of capillary attraction?
Did Michael Faraday say that a candle flame needed fresh air?
How did Michael Faraday prove that a candle needed constantly a supply of fresh air?
What part of the air did Michael Faraday say was taken by the burning candle?

This kind of question calls for the answer set forth by Faraday, and so the pupil will set up reflective processes endeavoring to remember what Faraday actually said. A better way of presenting the suggestive question is to direct it towards the pupil's personal experiences gained working out the project. Such questions are as follows:

Did you discover capillary attraction at work in the burning candle?
Or better,

Why is a wick necessary in a candle?
Will any kind of a thread or string serve as a wick?
How did you prove for yourself that a burning candle needs fresh air?
What part of the air is necessary to a burning candle?
What new gases or products are delivered to the air in the place of oxygen?
Are man and animal dependent upon the air as is the candle?

On the other hand, the teacher may not find it at all necessary to ask any questions; it may be the reverse, the pupil asking, the teacher answering. The best condition that can prevail is when teacher and pupils "gather together in the classroom for class conference" for the purpose of comparing their individual experiences and formulating a conclusion or solution for the problem in hand. No home work should ever be attempted that cannot be followed in class conference or in conference with the teacher, for the average pupil's efforts on home work are in direct proportion to the amount of attention given to it.

Time and space limits prevent the outlining of other projects and the pointing out of the sub-projects in each case for home work. However, let it be stated at this time that the child who goes into his home with proper oral directions or with easy written instructions of procedure for the study of the actual thing as it actually operates in his home, in his neighbor's home, or in the community will have a better understanding of the construction and working relationship of the parts than the pupil who is merely class taught from drawings whether they be on blackboards or in texts. The drawings that he makes of the system that he finds actually operating will be symbols of living concreteness compared with those of the student who endeavors to get his from diagrams alone. When each pupil has worked out a system for himself, then the drawings and designs of similar systems may be called to his attention and compared with those that he has made. In this manner heretofore meaningless diagrams and arrangements of things into systems expresses ideas and thoughts to him in much the same way that words, sentences and paragraphs of his story book express to his mind mental pictures of scenes and scenery. No problem in the textbook or from the teacher will have the same effect as that which the pupil makes for himself while reading gas or electric meters in the attempt to calculate the family expense in this respect for a day or a week. When this is done, the problem of the textbook offers itself as a wholesome challenge.

Throughout the course there is the desire on the part of most of the pupils to make or repair something in the home. In the

University-School we give the general science course to the pupils of the eighth grade and after they have worked through a few of the projects, they are continually seeking individual conferences concerning some piece of apparatus that has been suggested to them. One wants to make or repair a thermostat; another wants to rebuild or rewind a toy motor or dynamo or wireless set; still another desires complete details and advice on materials and details for the construction of a fireless cooker; another wants to know how to arrange lamps, wires and switches that will turn on the lights at the house and off at the garage; and so it goes throughout the course. We seize on these opportunities and make capital of them, for we make that problem that pupil's project, and when the right time in the course presents itself, we invite that pupil to present his problem and his solution of it to his fellow pupils, not merely to discuss and tell about the project but to demonstrate it.

Another agent that aids the teacher of general science to carry the problems of the course into the home is the portable projecting lantern, the lantern slide picture and the post card projector. The writer makes use of what he calls "the pupil's lecture." The teacher or pupil selects a group of slides or post cards bearing upon some future topic that will come up in the course. The pupil takes the slides or cards along with the lantern to his home. That night that family will have an illustrated lecture with the pupil acting as the lecturer. The help that he receives from the parent or friend to see deeper into the picture's meaning, or the criticism that he receives, depends, of course, upon the degree of family interest, and the ability of the members of the family to aid and criticize. Whatever the family attitude or ability be, the pupil has benefited from his recital and interpretation of the pictures to the family circle. The pupil may or may not be given a written description concerning the pictures that are loaned to him. It depends largely upon the subject matter. If the series of slides are on coal mining and the pupil is unacquainted with the machinery and terms of this industry, a written description must, from the nature of the case, accompany the slides. However, if the group of slides are on the handling and care of dairy products, it is better that he should carry his slides to the creamery and milk stations, and there find the machinery and tools and men in operation, and while there discover the worth and meaning of each picture and thus prepare his "pupil-lecture." The "pupil-lecture" thus

prepared is given in the class conference when the related project is under consideration. When properly stimulated and directed it is difficult to overrate the value and immediate effect of this kind of work on the part of the pupils.

Again, in every class, individuals will be found who possess cameras and who are doing their developing and printing. These individuals can be taught in one short lesson the details of lantern slide printing and binding. When this is done the teacher of general science has a resource upon which he may draw whenever occasion may arise. For example, long before we take up the project of "building our homes," one or more pupils are asked to locate homes in the process of construction and are instructed to make a set of pictures starting with the excavation for the basement and ending with the completed home. Interiors as well as exteriors are taken, and a full set of notes kept of observations made at the taking of each picture. These notes record the different classes of working men and the different kinds of labor that each is performing at the several stages in the development of the house; the various materials and their uses; the installation of the many systems; gas, electric, water, sewage, heating, ventilating and vacuum cleaning; and any other items that the pupil considers of interest in the development of his problem. In this sort of self activity the pupil must do his own discriminating, his own comparing and contrasting; he must weigh and evaluate for himself; he must assign values.

Since this paper has placed emphasis on the possibilities of home work, the writer would not have you think that all the work of the course in general science is to be done at home; that all the projects are home projects. By the very nature of the case some problems are confined in their demonstration at least to the laboratory and classroom. Furthermore the writer would not have you think that his methods of assigning a home problem for home study are the only methods of attack; he offers them to you as the best methods from his own experience. The writer's plea is that there be less empirical presentations, less abstraction and generalization concerning things and facts outside of the pupil's observation and experience; a plea for the most effective methods of science teaching since the days of Huxley, namely a method of teaching by projects. Once we have established such conditions, the attempts of teachers of general science to translate to pupils of tender age the principles of life as exemplified in the home and community will have become a possibility.

RESEARCH IN PHYSICS.

Conducted by Homer L. Dodge.

University of Oklahoma, Representing the American Physical Society.

It is the object of this department to present to teachers of physics the results of recent research. In so far as is possible, the articles and items will be non-technical, and it is hoped that they will furnish material which will be of value in the classroom. Suggestions and contributions should be sent to Homer L. Dodge, Department of Physics, University of Oklahoma, Norman, Oklahoma.

The Coolidge (Thermionic) X-Ray Tube.

This is the fourth of a series of articles on thermionic tubes.[1] Those who have read the former articles will recall that the thermionic valve and amplifier operate at reduced pressures and do not depend for their action upon ionization by collision. The Tungar rectifier, on the other hand, is able to carry its heavy currents only through the agency of positive ions produced by the impact of the electrons on the molecules of the gas present in the tube. X-ray tubes, while different from the above tubes in essential particulars, are in many respects similar. The ordinary tube depends upon ionization of gas, as does the Tungar rectifier (the Tungar rectifier could carry a small current through the agency of the thermions produced by the hot filament and is, in this respect, similar to the Coolidge tube), while the Coolidge tube is more like the thermionic valve. Mechanically, all of these devices are nothing but glass bulbs fitted with two or three electrodes. Yet, in spite of their apparent simplicity, they are highly specialized devices and, in their present forms, are the result of the skillful application of the discoveries of modern physics.

How cleverly the needs of the X-ray worker have been met by the use of thermions and the proper designing of tubes will be made apparent if the newer tube is compared with the older type, the one commonly found in the high school laboratory and, until recently, in the physician's and dentist's office.

The ordinary X-ray tube consists of a glass bulb with an aluminum cathode at one end, an aluminum anode at or near the other end, and a platinum-faced anti-cathode extending to the center of the bulb, with the face set at forty-five degrees to the axis of the tube. While in use the anode and anti-cathode are electrically connected. An appreciable amount of gas is

[1] "The Thermionic Valve," January, 1919; "A Thermionic Rectifier for Large Currents," March, 1919; "The Thermionic Amplifier," May, 1919.

always left in the tube, the pressure ranging from perhaps 0.001 to 0.010 mm. of mercury.

Although the number of ions present in this residual gas is normally very small, there are enough of them to produce further rapid ionization of the gas when a high potential is applied to the terminals of the tube. The effect is to accelerate the original ions and cause them to produce many more ions as they collide with the gas molecules. The electric field also serves to direct the positive ions toward the cathode which they bombard and cause to emit cathode particles (also called cathode rays). The field impels these cathode particles toward the anti-cathode. When they collide with this, their velocity is suddenly changed and X-rays are generated.

The penetrating power and "hardness" of the X-rays depend upon the velocity of the cathode particles which, in turn, depends upon the difference in potential of the electrodes. A "hard" tube is one that requires a high difference of potential to produce a discharge, the necessary potential increasing as the pressure is lowered.

In order that X-ray photographs shall be sharp, and often for other reasons, it is desirable that the rays originate over a very small area. This result is obtained by focusing the cathode particles upon the anti-cathode. Since cathode particles tend to leave the cathode at right angles to its surface, it is possible to shape the cathode to the right curvature to cause the proper degree of focusing. The focal distance is always several times the radius of curvature of the cathode, caused by the tendency of the similarly charged electrons to separate through mutual repulsion.

Since ordinary X-ray tubes depend upon ionization by collision, it is evident that any variation in the amount and pressure of the gas affects their characteristics. When first used they become "soft" as a result of evolution of gas from the electrodes. With further use they become harder and the gas is driven into the glass walls where it remains, entrapped by physical or chemical action or both. In the meantime they exhibit all sorts of disagreeable characteristics due to a large variety of causes such as static charges on the glass, etc. The absence of satisfactory scientific control is evidenced by the fact that it is good practice to "rest" tubes when they get in a "cranky" condition. Other difficulties met with in the ordinary tube are wandering of the focal spot, melting of the cathode, and blackening of the bulb,

caused by disintegration and evaporation of the electrodes.

Dr. W. D. Coolidge of the General Electric Company Research Laboratory at Schenectady made an extensive study of the ordinary type of tube and decided that many of the difficulties would be removed if the anti-cathode were made of a massive piece of wrought tungsten (melting point 3400° C.) and the tube freed from gas, in which case the electrons would have to be supplied in some other way than by bombardment of the cathode by positive ions. As a matter of fact, Dr. Coolidge succeeded in developing a tube free from practically all the limitations of the ordinary type.

The cathode consists of a tungsten filament in the shape of a flat, closely wound spiral, heated by a storage battery well insulated from the ground. The filament is surrounded by an electrically conducting cylinder which is connected either to the filament or to an external source of current by means of which its potential may be brought to any desired value with respect to the heated cathode. The cylinder assists in so shaping the electric field in the vicinity of the cathode that the desired degree of focusing of the cathode-ray stream upon the target shall result. The anti-cathode, or target, which also serves as an anode, consists of a single piece of wrought tungsten, weighing perhaps 100 grams. The bulb is about 18 cm. in diameter. The pressure, instead of being, as in the ordinary tube, a few microns, is as low as it is possible to make it, that is, not more than a few hundredths of a micron. Such a vacuum in the ordinary tube would require over 100,000 volts for the production of any current.

The action of the tube is remarkably simple. The hot filament emits thermions at a rate depending upon its temperature. Under the influence of the powerful electric field between the cathode and anti-cathode or anode the thermions are projected at enormous velocities against the anti-cathode in the form of a pencil of cathode particles which, on impact, produce X-rays. Accordingly, the intensity of the discharge current and therefore the quantity of X-rays is accurately controlled through the adjustment of the storage battery current flowing in the filament, while the hardness (frequency) of the X-rays, which depends upon the speed of the cathode particles, is determined by the voltage applied to the tube. Coolidge tubes have an enormous X-ray output and may be operated continuously without showing any appreciable change in characteristics.

In fact tubes have been run for hours while consuming several kilowatts of electrical energy.

Two characteristics of the tube serve to make it especially valuable in the taking of X-ray photographs or shadowgraphs, namely, the fact that the focal spot on the anti-cathode does not wander and that the glass does not fluoresce when the tube is operated properly. This latter fact is an indication that there is no bombardment of the glass by secondary cathode particles sent out from the target which would, of course, on impact with the glass give rise to X-rays. The sharpness of any shadow depends upon the smallness of the source. It is, therefore, desirable in an X-ray bulb that the focal spot be the only source of the rays and that this source remain stationery.

In the ordinary X-ray tube, in the case of a platinum target, it has been found that there are about three-fourths as many electrons leaving the target, and going to the glass as secondary cathode particles, as there are bombarding it in the form of primary cathode particles. This elimination of secondary cathode particle bombardment prevents the production of a large part of the useless and disturbing X-rays which emanate from the glass of an ordinary tube. The absence of bombardment of the glass appears to be based upon the fact that large numbers of positive ions present in the ordinary tube are here lacking. The inner surface of the glass becomes strongly negatively charged when the tube is first operated and, not being able to attract an appreciable number of positive ions, remains so. The presence of this negative charge upon the glass prevents further electrons either in the shape of primary or secondary cathode particles from going there.

The purpose of this brief article has been to call attention to the way in which the thermionic bulb has been adapted to the production of X-rays and the decided improvement over the ordinary cold cathode tube which results from such a small change. Anyone interested in the physics of the X-ray bulb should not fail to read Kaye's *X-Rays* (Longmans, Green and Co.). It is an authoritative and readable book.

ENGLISH EXPRESSION IN ITS RELATION TO TEACHING OF SCIENCE.

By R. R. Smith,

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In a recent number of School Science and Mathematics, I read with a great deal of interest an article relating to the failure of teachers of English to teach students to express themselves clearly on simple scientific subjects. I read it with interest for the reason that it was an attempt to state a condition of affairs as they exist; and it is absolutely essential that a condition be realized before there is the slightest possibility to find the cause of it and from the analysis of the cause work back to a remedy.

According to the article students cannot express themselves. Such seemed to me the conclusion at which the teacher of science arrived inductively after experimenting with many students. If I understood the article correctly he was rather just stating a deplorable condition and talking as if it were a state of affairs which could not be changed than seeking for a remedy or even trying to fasten the blame. He was even hesitating in his holding the teacher of English to account for the condition.

Of course we shall grant that it was kind of him to be charitable in his judgment of the teacher of English. It was kind of him to lead his reader to infer that the teacher of English was overburdened and for this reason could not be held responsible for getting results.

But, while we can admit that it was kind, we must at the same time affirm that it was far from scientific. If my gas pipes still leak after the plumber has been to my house, I immediately call him up and ask him to do his work again; he must do his work so well that the pipes will not leak. Such is the standard which we set up for every workman. He must produce results. Such is true also in the case of the professional man and the business man. Each must produce results. There is no reason why we teachers of English should ask to be judged by a different standard. To do so makes of us a group of parasites. As one member of the group I do not care to be judged in any other than the strictest scientific manner. I do not want to be placed in the group of parasites.

Our discussion immediately narrows itself down to this question: Can English expression be taught? Following this there

come two other questions which can be stated just as clearly; they are: What are the causes of the deplorable condition of affairs which was noted by the teacher of science quoted above? What are the remedies?

Briefly I shall set myself to the task of answering those questions in the remainder of this article. The first question is easily disposed of. English expression can be taught. It is being taught in newspaper offices, in business offices, in labor union meetings, and in all sorts of places where its teaching becomes at once an economic necessity. But only in rare cases is it being taught in our public schools. In short I think that we must first of all agree with our friend, the scientist, who was apologizing for us, that we do not succeed in getting our students to express themselves. In that case we have the case stated in plain terms. It remains but to reason back to the causes of this deplorable effect.

Why do not teachers of English get results?

In my own analysis of the question one reason has stood out paramount above all others. Teachers of English have tried and they are trying to teach English expression as a science and not as an art. I admit that this sounds trite; it is trite, but in so far as the teaching is concerned, when I have said that, I have said all there is to say. Look about you, and observe how people learn arts. How did you learn to walk? How did you learn to talk? How did you learn to swim, to ride a bicycle, to do any one of the hundreds of things that you do every day and do efficiently? You learned by watching another person do them and by trying to imitate him. It is true that you may have analyzed the reasons for doing certain things and that this analysis gave you an understanding of the principles which may have helped you in a further mastery of the technique of the proposition; but the learning of these principles at the time you learned to do any of the above-mentioned things hindered rather than helped you.

Just as you learned to do all the above-mentioned things by doing them after a certain model, so men and women who have learned to write have learned to do so by taking a model and painstakingly imitating it. Such was the case with Scott. It was so with Stevenson. It was so with Lincoln. In a newspaper office the cub learns to write his "story" in the same way. It is a matter of imitation. It has always been so. Yet in the face of such overwhelming evidence that English expression is an

art, it is treated as a science for the sixteen years of a student's life in the public school. Scarcely has the child learned to read before he is given a grammar and made to study sentence-structure. At first it is called language as a sort of camouflage; but it is grammar, the science of language; it is the study of the principles on which expression is based rather than practice in expressing himself. It is not even correct science, for in this early work he learns grammar as something illogical. He does not take grammar up as logic. Till he goes through the eight years of the common school he is year by year exposed to this dose of illogical grammar in the hopes that he may in some manner learn to write and speak; and in just a few cases he learns, but not through anything that the school does. He learns as a by-product; and for this reason there has grewn up a sort of uncanny belief that writing is a gift confined to a few individuals, that the ordinary student can not learn to express himself.

Nor did the grammar obsession cease with entrance to high school. For many years there was a shift in the point of view. From the science of the sentence the emphasis shifted to the science of expression, from grammar to rhetoric. But of late years there has been a rebound back in the other direction; the public, knowing only that high school graduates could not express themselves when they got through school, and not being in a position to know that they never could write by the study of grammar, demanded grammar in the high school; and now we have grammar in the high school; but still our students cannot express themselves.

Science in the grades; science in the high school; and in the university and college what? Some years ago the student was just asked to write—two short themes per week. Yes, you remember "English 7." You were supposed to produce two themes per week; after twelve years of the study of grammar and rhetoric you were supposed to be filled to the brim and thus to be able to write; but you could not. Do you remember your instructor in this course? He was a young fellow not yet versed in teaching anything; and he stormed; he realized that you could not write; he felt his own inability to teach you, and he blamed the high school and the grammar school. He was right.

But the public was not satisfied with that. The public awoke to the fact that not only were grammar school and high school graduates unable to express themselves in the English language

but that college graduates as well were short in that line. Then the public demanded grammar and got grammar. Now we have grammar in the college as well as in the grammar school and the high school; and still our students cannot express themselves.

Thus stands the first great indictment of our English teaching. It is taught as a science and not as an art.

What is the next outstanding fact in poor English teaching?

I realize that my statement may seem a heresy. But if I am to analyze this problem with any hope of reasoning from effects back to causes and thus to find a remedy, I must state facts as they appear to me. The next outstanding fact is that teachers of English cannot write. I am not stating this as an absolute fact. I do not have positive evidence. My evidence is negative. I have reached this inductive conclusion by reason of the fact that I have had forced upon me the absolute dearth of writings by teachers of English. It is true that we find a few scattered writings in school journals. But how few these are in proportion to the number who are teaching English. If my induction is correct, this in itself would be enough to make impossible the teaching of expression to students; for the very essence of teaching an art is some skill in that art on the part of the teacher. Imagine a man in a factory trying to teach something he himself cannot do.

My experience has been that the average teacher of English looks upon the teaching of expression with aversion. He delights in teaching literature; but he prefers that his colleague shall teach expression. But is he to be blamed for it? We have been going round in a cycle. His teacher before him was taught grammar; his teacher before him could not write. Our teachers have not been taught to write. It is not their fault. It is the fault of the system.

There is another outstanding fact connected with the teaching of English. Not only can our teachers of English not write. They cannot think inductively and deductively. I have in mind one man in particular who is making a desperate effort to solve the problem of teaching junior collegians how to write. He confesses that he cannot understand argumentation. He can make only a pretense of teaching it. One has only to glance through the average rhetoric to see that inductive and deductive thinking have not yet become a part of the equipment of the teacher of English or of the writer of so-called rhetorics and composition books.

In connection with this same thought comes another which is difficult to place. Teachers of English as a class are not broadly enough trained. We are coming to believe now that every boy and girl should have general science, that each should be grounded in economics and history. Just how can a teacher of English hope to teach expression if she is not grounded in the fundamentals of all the sciences? Yet in my own experience I find so few teachers of English who are really interested in the subject matter of other departments. When a discussion in botany or some other science is brought up, they seem bored, as if the discussion were something not germaine to their work at all.

Now, I have touched upon what seem to me to be the most vital points connected with the teaching of English. I have painted a rather drab picture; but it is not the drab of hopelessness. I have said that expression must be taught as an art. In spite of all the despair which seems prevalent in trying to teach it in the manner which it has been taught and is being taught to a great extent, the teaching of it as an art is not only simple but is to the person who himself takes a joy in expression, a joy. It consists merely in giving the student a model to work from and having him copy that faithfully. This must be done over and over again. From this he will go gradually to original work and the change will be so gradual that he will not know when it comes. But this expression must be at frequent intervals —daily, if possible, and must be read word for word and graded. By such a method a student can be taught to write in less than a week. That does not mean that he knows all that there is to know; but it means that he can write, just as after he tries for a certain time he can ride a bicycle. It is so very, very simple that once he sees how to do it he can scarcely realize why he considered it difficult. I am tempted to go into detail concerning devices and means at this point, but such is out of the scope of this article.

I have further said that teachers themselves cannot write, that they do not think in logical terms, that they as a class have not a broad enough interest in the subject matter of other departments. If we grant that my indictment is a true bill, the remedy is not hard to find. I have already indicated that a shift from the science side to the art side will make all the difference in the world; our teachers cannot write; then, if we are to produce writers of our students we must either find teachers who can write or train the ones we already have to do

so. If our teachers cannot think logically, we must get teachers who can do so or we must train the ones we have to do so; if they have not a broad foundation for their work we must either get teachers who have or we must convert our present teaching force into one with a broad foundation. Ideally, we need to go out and induce that great body of men and women who are writing for our newspapers and magazines to come into our schools and teach our students how to write.

Here in the school of Engineering of Milwaukee we are working on the problem intensively. We have a group of teachers of English who have been chosen for a particular work, that is to teach students to read and to express themselves. We have no ruts in which we must keep. We must produce results. In a short time we shall be able to give to our friends some few results of the experiment. In conclusion I wish to add to what I have already said that our spirit here is that we do not wish to be considered as a department in ourselves. Our department is a handmaiden of the other departments. We consider it our business to see that our freshman students can read their general science text. We go on the theory that they know only that which they can express in clear English. We take it as our task to train students to read chemistry, physics, and botany. Certainly this means that we must become familiar with these texts ourselves. If we ask a student to write a theme on the dry cell, we must be able to do so ourselves. It is work—hard work; but just as in a newspaper office at the close of the day one has in front of him his day's work in black type, we have here at the end of the day a direct check of our efforts. Then, too, from out of this we think we shall evolve a technique that will make for a keener appreciation of literature than students have usually, because all that we do must be based on truth; we may not pretend; we may not be hypocrites. Of the sunrises, the snows, and rains, the mud, the smoke, and the hundreds of sights and sounds and smells that come to us each day we are certain of appreciation. This is literature. Our students sense it as such. They are learning to read and appreciate and enjoy; they are learning to express themselves simply and clearly; for they are working on expression as an art, and we have the fear of falsity too much in our hearts to ask them to express something that we ourselves cannot express; by our rigid training in science and economics and education and philosophy we have been forced to think logically, inductively and deductively; we must have a broad training.

STEPS NECESSARY TO ESTABLISH GEOGRAPHY AS A FUNDAMENTAL HIGH SCHOOL SUBJECT.[1]

By F. E. WILLIAMS,

University of Wisconsin, Madison, Wis.

A man's worth to the community is measured by his ability to meet and solve the problems which arise in a time of crisis. In like manner may the value of a science be appraised. If a science furnished its quota of strong, capable men in the hour of need, it has proven its right to exist. In the struggle which involved the whole world did geography furnish its quota of trained men and did these men acquit themselves creditably in the fields to which they were called? We can answer both of these questions in the affirmative and further affirm that men of geographical training were often the leaders and among the first to suggest profitable and valuable problems to be solved.

Geographers were called into all branches of war work. Their names will be found high upon the roster of practically all branches of service—some in uniform, many not, but all working with the zeal and intellect which they had developed while studying in a field that not only promotes clear thinking, but inspired high ideals of citizenship. Because of their knowledge of resources, demands, and transportation problems, perhaps no group of scientists more clearly understood the difficulties which confronted the nation. It is unnecessary to enumerate the different organizations in which geographers served or the names of the men who discharged their duties with precision and often with distinction. A practically complete list of these men may be found in an article by Professor Whitbeck read before this section last year and published in "School and Society," February 22, 1919. Many other geographers received urgent calls to go into similar lines of work, but they could not be spared from the departments, already much weakened, of the higher educational institutions of the country.

And the call for geographers continues. If one had suggested a few years ago that geography might become a "bread and butter" study, he would have met with ridicule. Yet within the last year several geographers have been offered and some have accepted positions carrying salaries that would make the average faculty man feel that the millennium was at hand. Even

[1]Read before the Earth Science Section, C. A. S. and M. T., Lake View High School, November 29, 1919.

the United States Geological Survey comes out with an announcement of an examination for "Mineral Geographers," no doubt suggested by the excellent work of the geographers and by the geographical knowledge of the geologists which was of such great value to the government in the recent crisis.

With such evidence before us, it should be easy to firmly establish geography in the high schools. It has just been demonstrated that it is one of the studies which has high practical value as well as intellectual discipline. It can be more clearly pointed out now, more clearly than ever before, that geography is one of the studies that makes for potentiality and good citizenship. By geography I mean the kind of geography which makes us familiar with the resources, the broader lines of historical development, the institutions, and the inclinations of the peoples of the world. It is a trite saying that "This is the day of the specialist," but never was the world more in need of the specialist who has a broad enough education to be able to think nationally and internationally.

What geography most lacks is a past—a past to give it equal prestige with other sciences. It is true that we have had many different types or divisions of geography taught for many years, but there is not, in the minds of the public, a clear idea of what is meant by geography if, indeed, there is unanimity of opinion among geographers themselves. It seems, however, that geographers at present are pretty generally agreed on the fundamentals to be emphasized in the teaching of geography. In your department of earth science you have proposed "that the aims of geography teaching shall be tentatively classified as:

"(1) Understanding, appreciation, and control of the pupil's daily environment,

"(2) Training in ability, such as problem seeing and problem solving,

"(3) Acquisition of a fund of information pertaining to the countries and peoples of the world,

"(4) To get a setting for the interpretation of English and history."

You have then put yourselves on record as favoring regional geography (local, sectional, national, or world wide) so developed as to bring out the relationship of geographical environment to progress and development. With this, I believe, most geographers heartily agree. Having reached an agreement, let us stand for the development of geography as if we believed in it.

Too long have we as geographers attended educational meetings and defended the teaching of geography when we should have been presenting ideas to be taught. How many pages of the geographical journals and other educational papers have been given over to the defense of one or many phases of geography as a high school subject? Perhaps much of this was necessary in the past, but it is certainly unnecessary now. No longer need one blush when called upon to admit that he is a teacher of geography. People in general have little faith in a man who does not believe in himself. If we would firmly establish geography and give it the prestige it deserves, let us get together and stand for the principles we have established so that others seeing may believe that our science is as valuable as the best. The papers presented here show that you no longer are seeking to justify geography but are seeking to enrich and enforce its content so that it will have a present, and the future will find it with a well established past.

Another lack that has been serious for geography has been the want of a good textbook. True we have had several good texts in physical geography and commercial geography, but it was only very recently that any attempt was made to write a text along the lines suggested by your committee. There are now several manuscripts about ready for the printer and doubtless more will follow. A good text book is necessary to act as a guide as well as to supply principles and facts. Of course, the established textbook should be supplemented by other textbooks, special papers, periodical literature, and government publications. At the University of Wisconsin, at the beginning of the present semester we were forced to proceed several weeks without textbooks as they were not available. The result was harder work for the instructors, poorer results as to the facts learned, but worst of all was the effect upon the students in regard to their attitude toward the course. The textbooks were received about six weeks after the beginning of school, and we are finding it quite difficult to get the students down to real work in a course where the instructors were compelled to lecture and quiz upon their own words. True the work was unusual on account of the exceedingly large enrollment, but in general very few students below the junior class in college or the university are able to do effective work without some kind of a textbook. It becomes a sort of clearing house for facts assembled from other sources and is an ever present port in time of

storm when disputes arise and examinations threaten. Let us see to it then that the textbooks which appear fulfill the requirements of a good sound geography course however much they may differ in detail. Newspapers and periodicals influence public opinion. Geographers and other science teachers must influence boards of education in their choice of textbooks. Otherwise, geography will lose this wonderful chance to become firmly established on a par with the other sciences. In order to do this it will be necesssary to write, talk and act. Above all, always be on the alert that some book company through its agents does not put over a text that is unteachable or omits the essentials which make geography a living, interesting, and recognized study. Adoption of poor textbooks at this time would do much to lower the prestige which geography has recently attained.

Important as a textbook is, we must have someone to interpret it and supplement it. So our greatest factor of success enters in the person of the teacher. A teacher may make or break the vantage gained. Geography is so closely interwoven into the economic and industrial problems of the day that its teachers must not idle for an instant. It is not enough to teach the textbook facts, they must be supplemented by up-to-date articles of world interest. Geography cannot confine itself between the covers of any book so it must have an especially wide awake teacher who is always on the lookout for interesting facts. Too long has the class in geography in the high school been shifted to the teacher with a free period.

Successful geography can only be taught when the teacher is on the alert constantly for new material, so, necessarily, it cannot be placed in the hands of one who will treat it only as a side issue. A poor teacher is a stumbling block to the advance of any subject but how much more is this true in geography. The teacher of the average science must be a specialist through long attentive work in his particular study. But the geography teacher must have a background before any specialization can be made. One cannot teach geography, especially the most interesting phases, as taken up in courses of human response and geographical influences without a firm foundation in history dealing particularly with exploration, settlement, and progress, as well as a knowledge of the soils, plants, minerals, and configuration of the land.

But no amount of specialization will ever make a perfect teacher unless alertness and observation and initiative are there.

There is such a fund of geographical facts in every periodical that any good magazine dealing with world topics contains a vast amount of useful material that enriches the student's knowledge. While studying the harbor of New York, some time ago, I referred my class to an article in the *World's Work* for December, 1915. One of my students was much interested in some facts which he acquired about Colombo. He knew nothing of the city before, and its large shipping tonnage in graphite particularly took his attention. This opened up to him an especial interest in Colombo and graphite which he followed up and enlarged upon. The teacher must never fail to utilize opportunities to awaken an interest in up-to-date matters and put the pupil in touch with the best thinkers and writers who are studying the questions of the day.

The position which geography has reached in the colleges, and universities is a further aid to the establishment of this study in the high school. For years advocates of the teaching of geography in the high school have had to fight for recognition from the higher institutions of learning. As a high school study it should now receive an impetus from these higher institutions where it is now permanently established. Boards of education find it prominent among the studies in the catalogue. Graduates are going out to proclaim its usefulness. In these institutions are trained the men and women who must present geography in such a way that the most skeptical will be convinced of its value. The number of students taking geography in the universities has increased by leaps and bounds. In the University of Wisconsin the rate of increase has been several times as great as the rate of increase in total attendance. Let us compare the records of 1916, the last year before we entered the war, with those of the present year. In 1916 the attendance, excepting the summer school, was 5,318. In 1919 the attendance is about 7,000. This shows an increase of a little over 31 per cent in total enrollment. In the first semester of 1916 there were 542 students enrolled in geography, while at present there are 1,156, a gain of over 113 per cent. Such an enrollment in geography in the university cannot help but stimulate its growth in the high school.

A more opportune time could scarcely be found for the establishment of geography in the high school. In constant demand are the men who know the principles underlying the production, transportation and delivery of commodities.

INTRODUCTORY COURSES IN BOTANY IV.

By Bradley M. Davis,

University of Michigan, Ann Arbor.

(Continued from January, 1920.)

Outline No. 11.

A year's course, seven periods a week, primarily for first or second year high school pupils, but sometimes adapted to other years.

1. Problems in water relations of plants. a. Evaporation from plants. b. Transfer of water and the structures involved; stem structure and characteristics of woody stems. c. Absorption of water; root structure; osmosis.

2. Problems in nutrition. a. Carbohydrate manufacture, and the anatomy of the leaf. b. Leaf arrangement as related to photosynthesis. c. Independent plants. d. Saprophytes and parasites. e. Use made of elaborated food; digestion, transference, storage, assimilation.

3. Problems of growth, propagation, and reproduction. a. Opening of bud and growth of shoot. b. Structure of buds. c. Utilization of stored food. d. Growth from tubers, bulbs, etc. e. Stolons, runners, root sprouts. f. Leaf cuttings, soft wood and hard wood cuttings. g. Flower and seed; pollination, fertilization.

4. Dispersal and germination of seeds. a. Methods of dispersal; field and laboratory study of effectiveness of devices. b. Growth from seeds. c. Structure of seeds.

5. Response to environment. a. Response to temperature, gravity, light, touch. b. Competition between plants and between branches on the same plant. c. Healing of wounds; callus formation; tree trimming. d. Transplanting.

6. Dependent plants, social and economic problems. a. Bacteria; relation to decay and disease. b. Yeast; physiology and morphology. c. Molds; growth, distribution and structure. d. Parasitic fungi and plant diseases. e. Mushrooms. f. Wood-rotting fungi.

7. The principal groups of independent plants. a. Algae; vegetative structure, manner of life, reproduction. b. Mosses; vegetative structure, the problems of water supply and nutrition, gross anatomy of reproduction. c. Ferns; vegetative structure, the problems of water supply and nutrition, asexual reproduction. d. Gymnosperms; vegetative structure, water supply and nutrition, gross morphology of reproduction. e.

Angiosperms; review vegetative structure and methods of water supply and nutrition; study flowers and seeds as supplementary to earlier study of same subjects on account of greater seasonal abundance of material.

8. Problems of industries founded upon plant activities. a. Plant breeding problems. b. Soil and its problems. c. Weeds and the problems of weed control. Much discussion of the relations of plants to industries and particularly to agriculture is involved in earlier parts of the course. Only problems requiring additional separate treatment appear here.

9. Plant geography. a. Local problems. b. Regional distribution. The amount of attention given to this section must vary widely, due to differences in local problems, age and grade of class, amount of time available, school program, and library equipment. They cannot be outlined in advance.

"The course is administered with the knowledge that only a negligible minority of those who take botany in a public high school will ever study it in college. It is organized fundamentally about the life of the plant and the problems of social significance involving plants. Function precedes structure in order of presentation, but structures are studied when, and so far as, desirable in order to understand the work of plants and their relations to human welfare."

"With a class of very immature pupils, as an exclusively ninth grade class, many of the topics must be somewhat simplified. This is particularly true of Section 7. On the other hand if the class is made up largely of third and fourth year pupils this section may be considerably amplified."

OUTLINE No. 12.

A year's high school course, seven periods a week, forty-five minutes to a period.

1. General structure of a simple seed plant such as Bouncing Bet to obtain an understanding of root, stem, and leaf regions, their functions, and the structure and functions of a simple flower. (No details of morphology)

2. Careful laboratory studies on two types of composite flowers.

3. Herbarium collection made by the class as a whole of common autumn garden flowers, classified as simple or composite, and named with the aid of florist's catalogues.

4. Weeds. Field trips for identification and careful study to determine reasons for their success. Study of vegetative

reproduction. Calculations of numbers of seeds to individual plants. Herbaria of weeds.

5. Pollination. Study of various adaptations of flowers to different agencies of pollination. Field work to observe insects visiting flowers.

6. Seeds. Methods of dispersal. Service to plants. Uses to man.

7. Field work on identification of common trees by their leaves (emphasis on parkway trees). Leaf division. Venation. Margins. Herbaria of leaves of trees.

8. Forestry problems (illustrated with lantern slides). Laboratory work on useful woods, study of wood grain, weight, uses to man.

9. Plant societies. Demonstrations with lantern slides. Field trips to the three types of plant associations.

10. Fall gardening. Bulbs, cuttings, etc. Laboratory work on the care of house plants.

11. Algae. Microscopic work to show evolution of plant body from single cell to cell mass. Evolution of reproduction, fission, asexual spores, sexually formed spores. Osmosis, plasmolysis. Photosynthesis. Algae from an economic standpoint. Demonstrations of brown and red algae.

12. Bacteria. Agar-agar, broth, potato cultures. Study of methods of food preservation with laboratory experiments. Microscopic study of living bacteria raised in hay infusion. Economic importance. Relation to disease.

13. Fungi. Raising of molds. Study of structure, reproduction, and life habits of bread mold. Life history of wheat rust. Economic importance of fungi.

14. Evolution of seed plants through a brief study of bryophytes for alternation of generations and of pteridophytes for vascular system and the development of complex sporophytes. Economic importance of these groups, peat, coal.

15. Gymnosperms. The seed. Structure of leaves which permit indeciduous habit. Economic importance of group from the standpoint of lumbering and naval stores. Collection of evergreens.

16. Deciduous trees in winter. Structure of buds and twigs. Identification of trees from twigs with field work on identification of trees in winter conditions.

17. The seed. Types. Structure and germination. Seed testing. Experiments on food storage and vitality.

18. Soils. Microscopic structure and simple analysis of soils found in yards of pupils. Experiments on water content and temperature as affected by color, slope, air spaces, etc.

19. Seedlings. Study of various types germinated in different soils. Stages of development. Response to various stimuli, light, gravity, etc., to be worked out by experiments. Respiration. Digestion of starch by germinating barley.

20. Root structure. Study based on radish seedlings and other material. Tests for food storage in turnip, parsnip, etc. Economic importance of roots.

21. Stem structure. Arrangement of tissues in various types. Food storage tests. Experiments on girdling, food transportation, cuttings, grafting. Economic importance of stem products, rubber, etc.

22. Leaf structure. Microscopic study of stomates and cross section of a simple leaf such as the lily. Experiments in photosynthesis. Comparison of leaves of desert plants with those of water plants, with those of garden plants. Transpiration.

23. Gardening. Each pupil to raise at least three kinds of vegetables one of which is to be a succession crop. Plot prepared to scale.

24. Study of fertilizers. Experiments with seedlings.

25. Preparation of soils.

26. Study of vegetables chosen by the majority of the class. Their origin, requirements, methods of planting, care, diseases, insect pests, harvesting, food values.

27. Spring flowers. A few plant families. Emphasis on classification. Use of scientific keys.

28. Fruits. Structure and development from flower. Pollination and plant breeding. Mendelism. Study of cereals with special emphasis upon wheat and corn, and their breeding. Importance as food.

"High school botany should emphasize that which is of importance to pupils who have not yet had much scientific training by dealing with topics of everyday experience in such a way as to develop a scientific attitude. To keep the plant before the pupil as far as possible as an intact living thing, many opportunities are offered in the way of caring for plants in and outside of the laboratory. Where there is not sufficient space available in the school garden, pupils who have sufficiently large home gardens may be given credit for them. This demands

personal visits on the part of the instructor, but the results are well worth the time expended."

OUTLINE No. 13.

A year's high school course in an agricultural region, eight periods a week, forty-five minutes in a period.

1. Study of a plant as a whole. The parts and their functions. Life history.

2. Seeds. Structure and germination. Seed dispersal. Seed testing, agricultural application. Propagation by seeds. Weeds, dispersal by seeds, identification, extermination. Kinds of food in different seeds, tests of foods.

3. Fruits. Study of four different types of fruits. Comparative and diagramatic work.

4. Bacteria. Structure, growth, etc. (experimental and topical). Uses of bacteria in various industries, visiting such as are available. Uses of bacteria in agriculture, soil fertility. Most common bacterial diseases, how spread, symptoms, prevention. Bacteria and dairy products.

5. Yeast. Structure, growth, etc. (experimental work). Fermentation. Vinegar production.

6. Algae. Study of a few common forms. Study of the cell.

7. Molds. Structure and life habits.

8. Mildews. Structure and life histories. Hosts, losses, how prevented. Various fungal diseases on potato, different trees, shrubs, etc.

9. Smuts. Life history, losses, preventives on grain and corn.

10. Rusts. Life history, losses, preventives on cereals.

11. Mushrooms. Life history and importance.

12. Lichens (very briefly).

13. Mosses. Life history and importance.

14. Ferns. Life history, importance, coal.

15. Equisetum. Life history, former importance, coal.

16. Gymnosperms. Life history. Structure of stems in detail as introductory to stems of angiosperms. Economic importance.

17. Roots. Main classes. Anatomy. Physiology, absorption, osmosis, etc. Ecology. Soils, composition and formation, water in soil, enriching soil, rotation of crops, irrigation and dry farming. Topical work based on magazine articles, planning of farms, intensive farming, conservation.

18. Stems. External morphology. Internal structure. Physiology. Ecology. Grafting, etc.

19. Leaves. External features of foliage leaves. Physiology, experimental studies. Ecology.

20. Buds. Winter and spring conditions. Morphology. Physiology.

21. Flowers. Detailed study of several representatives. Mechanism for pollination. Relations of insects to pollination. Field work.

22. Plant breeding. Principles. Work of prominent breeders.

23. Monocots and dicots. Difference in structure. Main economic groups.

24. Forestry. Classification and identification of common local trees, field trips. Uses of trees. Principles of forestry. Conservation, topical reports.

25. Gardening. Principles of gardening. Practical work in hot beds and gardens if possible; in which case the subject must be introduced earlier.

26. Orcharding. Fruit raising, etc.

"This course aims to teach the important facts over the whole field of botany with reference to structure, physiology, evolution and ecology. Special emphasis is laid throughout on economic and practical knowledge such as the student can use directly in his garden and farm work. Current magazines, bulletins and reprints are used as constant reference material."

OUTLINE NO. 14.

A year's high school course, seven periods a week, forty minutes to a period.

First Half Year:

1. A general study of a simple plant such as nasturtium or Bouncing Bet, sunflower or other composite followed by an exhibit of many composites.

2. Study of one weed selected by the pupil with exhibits of numerous weeds tabulated in outline form giving name, where found, annual or ?, how seeds are scattered, harmful to ?, how controlled, etc.

3. Autumn fruits. Studies of dry and fleshy fruits, nuts, pods, burs, akenes, berries, pomes, etc. "Apple show," a study of all available varieties for variation in color, shape, flavor, use, etc.

4. Bulbs. A two-day study of bulbs suitable for autumn planting and of methods of forcing winter blooming bulbs, followed by the care of at least one paper-white narcissus plant through blooming.

5. Bacteria. The plating of many cultures of bacteria from water, milk, air of cars, stores, class room, etc. Transfer of cultures to gelatine and agar tubes. Staining of bacteria. (Media prepared by the instructor.)

6. Algae. Structure and reproduction of Pleurococcus and Spirogyra. Exhibit of algae.

7. Fungi. A study of yeast and mushroom.

8. Moss. Structure, reproduction, and life history (optional).

9. Fern. Structure, reproduction, and life history.

10. Gymnosperms. General study of coniferous types, pine, spruce, hemlock, fir, etc.

Second Half Year:

11. Seeds and seedlings. Study of bean, corn, and pine; economic uses of seeds, tests on food content, vitality, various tropisms.

12. Roots. Absorption, storage, modified types.

13. Stems. Structure and function, modified types, economic importance. Study of woods and identification of trees in winter condition.

14. Leaves. Structure, photosynthesis, transpiration, storage, modified types.

15. Flowers. Structure and function of flower parts. Study of families, willow, arum, lily, mustard, violet, legume, figwort, rose, composite. Competitive reports on flower calendar covering wild and hardy cultivated plants.

" The prime object of the course is to stimulate the pupils interest in plants as factors in the present and future years of his life, featuring his dependence on plants for his existence and comfort, in other words to encourage a living interest rather than to foster a memory of botany finished."

OUTLINE NO. 15.

A half-year high school course, five periods a week, forty minutes to a period.

1. Morphology of common plants. The structure, modifications, and uses of roots, stems, buds, leaves, flowers and fruits.

2. The physiology of roots, stems, leaves, and seeds.

3. Commercial products obtained from roots, stems, leaves, fruits, and seeds.

4. Trees. Identification of common trees both in their winter and summer condition.

5. Soil study. Composition and origin of typical soils. Drainage, tillage, fertilizers, and crop rotation.

6. Wild flowers. Identification and habitat of common wild flowers.

7. Identification and field study of weeds common to fields and garden.

8. Decorative planting and garden planning. Principles governing the arrangement and choice of plants used in garden and on lawn. Rules for planting vegetables; care of soil, hot beds, cold frames.

9. Plant breeding. Natural and artificial methods of producing new fruits, grains, and flowers.

10. Seeds, seedlings and fruits. Types of seeds, fruits and seedlings.

11. Plant ecology. Influence of light, water, and soil. Plant associations.

12. The cell. Its structure and the properties of protoplasm.

13. Algae. To demonstrate cell division and conjugation, and the increase in complexity of the plant body. Their economic value to aquatic life and to man.

14. Fungi. As dependent plants; their methods of reproduction and their relation to disease in both plants and animals. Edible and poisonous mushrooms.

15. Field trips. Trips to be taken in season during school hours and on Saturdays for the study of trees, wild flowers, weeds, fungi, etc.

"This short course in botany for second year students in a high school of a large city aims to stress the economic side of the subject, since that is demanded in this particular school. At the same time the teacher is trying to present the subject in a scientific spirit, to give the student an idea of the plant as a living, working organism, to open the student's eyes to an interest in plant life as they see it about them in their walks to and from school, in the parks, in their visits to the country, and in their backyard gardens, if they are fortunate enough to possess a backyard."

Outline No. 16.

A half-year course of high school grade to prepare for a study of farm crops, three recitations, two laboratory periods each week.

1. Algae. Study of two types, sexual and asexual reproduction.

2. Bacteria. Rather extensive study with special reference to those that concern the farmer in plant disease, dairy practice, etc. Nitrifying bacteria.

2. Fungi. Study with special reference to those that cause plant diseases such as wilt, scab, blight, smut, rust, etc.

4. General studies on mushrooms, lichens, liverworts, mosses, and ferns so that the pupil may be able to recognize them but without details of organization.

5. Brief study of gymnosperms taking up those of importance on farm wood lots.

6. Plant physiology. Based on study of cells, leaves, vascular bundles, root hairs, etc. Osmosis, transfer of materials, photosynthesis, etc.

7. Foods manufactured by the plant with a study of various grains and their analysis.

8. Water relations of plants and how man may conserve water.

9. Study of soils, humus, fertilizers, etc.

10. Comparative studies on monocots and dicots with identification.

11. Types of roots, tubers, bulbs, stems, fruits, etc., with classification of those that are raised on the farm.

12. Fertilization, cross pollination compared with self pollination, plant breeding, mutations.

13. Practical studies on budding, grafting, cutting, etc.

14. Laboratory studies on samples of fertilizers.

15. Field trips for the study of weeds.

16. Visits to some of the best farms in the neighborhood.

(*To be Continued.*)

For the first time at the University of Cincinnati, College of Commerce students are admitted on a co-operative basis. The co-operative experiment has proved so successful in the Engineering College that it was decided to extend its application. To make greater the probability of success, the co-operative feature of the College was placed under the control of Dean Herman Schneider. There are now 500 Co-ops in the Commerce College and the system seems to be working nicely. The upward bound in registration applies to the night as well as to the day Colleges. More out-of-town men and women than ever before are seizing the opportunities furnished by the University for getting an academic education by night study. The night College has brought the University into touch with the working people and makes it more popular with the rank and file of the citizenry of the city. Late returns are expected to bring the total enrollment to 800 students in the night courses.

A SUGGESTION FOR TEACHING THE ABSOLUTE ZERO.

G. W. WARNER,

Englewood High School, Chicago.

In the following exercise no claim is made for anything new either in the apparatus used or in the method of performing. But by use of the questions given below, the writer thinks he has had better success in teaching the fundamental ideas of the absolute zero and the absolute temperature scale than by the use of any of the published laboratory exercises or text book discussions.

The ordinary type of constant volume air thermometer was used and the usual precautions were taken for drying the air and securing accurate results. The students were just beginning the study of heat, two days having been spent in discussing the difference between heat and temperature and in becoming familiar with the use of the Fahrenheit and Centigrade scales. In each section the experiment was performed as a class exercise, three students doing the work under the direction of the instructor, the remainder of the class observing and working out the results. In no section was the per cent of error greater than three per cent; hence the experiment was satisfactory both from the standpoint of accuracy and of knowledge gained. The outline follows:

THE PRESSURE COEFFICIENT AND ABSOLUTE ZERO.

Purpose: To study the effect of change of temperature of a quantity of air on the pressure which it exerts, the volume being kept constant.

Apparatus: Constant volume air thermometer, barometer, steam bath, ice bath.

Data and Results:

Barometric pressure today, B, = cm.

Bulb in ice

Height of mercury in closed arm, H', = cm.

Height of mercury in open arm, H'', = cm.

Pressure on inclosed air, $P_f = (H''—H') + B$ = cm.

Bulb in steam

Height of mercury in closed arm, H', = cm.

Height of mercury in open arm, H''' = cm.

Pressure on inclosed air, P_b, = $(H'''—H') + B$ = cm.

Total change of pressure, $P_b—P_f$, = cm.

Total change of temperature = 100 Centigrade degrees (Approx.)
Change of pressure per degree change of temperature for each centimeter of pressure at freezing, $\frac{P_b - P_f}{100\ P_f}$, = . This number is called the pressure coefficient. What two assumptions have been made in determining it?

Draw a graph of the results using temperature as abscissas and pressure as ordinates, and extend the graph backward through the Y-axis until it cuts the X-axis. Call this point A. What third assumption has now been made? Why are two points sufficient to determine this graph? What pressure would the inclosed air exert if the temperature were reduced to that represented by point A? According to the kinetic theory what is the cause of gas pressure? What must be the condition of the molecules of the gas at point A? What is their kinetic energy of translation? Explain. Assuming that heat is kinetic energy of translation of molecules, how much heat has the gas at this point? This point is called the absolute zero. Define it using the kinetic theory idea just developed. From your graph what is this temperature on the Centigrade scale? Calculate it using your pressure coefficient. What is the accepted result? What is the freezing point on the Absolute scale? Boiling point?

NEWS ITEM FROM THE NATIONAL RESEARCH COUNCIL.

A special committee of the National Research Council, consisting of Dr. R. M. Yerkes, chairman, and Dr. M. E. Haggerty of the University of Minnesota, Dr. L. M. Terman of Stanford University, Dr. E. L. Thorndike of Teachers College, Columbia University, and Dr. G. M. Whipple of the University of Michigan, with financial support from the General Education Board, have formulated a plan for using the army mental tests in schools. Such intelligence tests have been used in schools for some time on individual children, but the new plan provides for handling them in groups, even whole class-rooms at a time. The committee selected about twenty tests for careful trial. This trial was made on five thousand children. As a result the committee has now been able to select from the tests two series which seem to be the most satisfactory and these will now be tried on several thousand more children in order that they may be further perfected before they are finally offered to the teachers of the country for general use.

This carefully worked out program for group tests will make it possible and practicable to make wholesale surveys of schools annually, or even semi-annually, so that grade classification and individual educational treatment can be adjusted with desirable frequency. The army tests, on which these new group tests for children are based, and which were used with striking success and advantage during the war, were originally devised by a group of psychologists working under the auspices of the National Research Council. This mailer may be obtained from the office of the Executive Secretary, 1201 Sixteenth St., Washington, D. C.

NATIONAL ACADEMY OF SCIENCES.

The Carnegie Corporation of New York has announced its purpose to give $5,000,000 for the use of the National Academy of Sciences and the National Research Council. It is understood that a portion of the money will be used to erect in Washington a home of suitable architectural dignity for the two beneficiary organizations. The remainder will be placed in the hands of the Academy, which enjoys a federal charter, to be used as a permanent endowment for the National Research Council. This impressive gift is a fitting supplement to Mr. Carnegie's great contributions to science and industry.

The Council is a democratic organization based upon some forty of the great scientific and engineering societies of the country, which elect delegates to its constituent Divisions. It is not supported or controlled by the Government, differing in this respect from other similar organizations established since the beginning of the war in England, Italy, Japan, Canada, and Australia. It intends, if possible, to achieve in a democracy and by democratic methods the great scientific results which the Germans achieved by autocratic methods in an autocracy, while avoiding the obnoxious features of the autocratic regime.

The Council was organized in 1916 as a measure of national preparedness, and its efforts during the war were mostly confined to assisting the Government in the solution of pressing war-time problems involving scientific investigation. Reorganized since the war on a peace-time footing, it is now attempting to stimulate and promote scientific research in agriculture, medicine, and industry, and in every field of pure science. The war afforded a convincing demonstration of the dependence of modern nations upon scientific achievement, and nothing is more certain than that the United States will ultimately fall behind in its competition with the other great peoples of the world unless there be persistent and energetic effort expended to foster scientific discovery.

MINNESOTA SUPERINTENDENT TO MANAGE CLARK AGENCY.

Word has just been received in this office that Superintendent Joseph V. Voorhees of Winona, Minnesota, has tendered his resignation to the Board of Education to take place as soon as convenient so that he may take up his duties as Manager of the Northwestern office of the Clark Teachers' Agency.

Mr. Voorhees is one of the best known superintendents in the state having been in Winona for the past eleven years, seven of which he acted as superintendent and four, as principal of the High School. During this time he has taught several consecutive sessions at the summer schools of the Michigan State Normal College, Ypsilanti, and the State Normal School at Winona, Minnesota.

The distribution of teachers is a function of prime importance to our educational system and it augurs well that one of the chief distributing agencies should choose a man of Mr. Voorhees capabilities and experience to assist in this important work.

The northwestern office of the Clark Teachers' Agency is well known to educators. Its merited reputation for expedited service has compelled the use of enlarged office space.

Permanent quarters have been secured on the fourth floor of the Globe Building of Minneapolis.

LARGE PRODUCTION OF PHOSPHATE ROCK.

The three minerals most needed to make our agricultural industry more productive and more prosperous are potash, nitrate, and phosphate. Most of the potash and nitrate we use is imported, but our domestic supplies of phosphate are abundantly ample to meet all our requirements, and for years we have been heavy exporters to Europe. The total quantity of phosphate rock sold in the United States in 1918 was nearly 2,500,000 long tons, having a value of more than $8,000,000, over twice as much as was produced in that year in all the rest of the world. Florida alone produced more than 2,000,000 tons, having a value of about $6,000,000.

A report on the phosphate-rock industry by R. W. Stone, which has just been published by the United States Geological Survey, Department of the Interior, gives the details of production in 1918 by states and by kinds of rocks, shows the world's production by countries and by years from 1910 to 1918, and includes tables showing exports by countries. The report also describes briefly the distribution, character, and methods of mining the phosphate-rock deposits in Florida, South Carolina, Tennessee, Kentucky, Arkansas, and the Western States, gives a resume of the foreign phosphate deposits, and a bibliography. A copy of the report can be obtained on application to the Director, United States Geological Survey Washington, D. C.

EXAMINATION BY THE GEOLOGICAL SURVEY OF REGIONS THOUGHT TO BE OIL AND GAS BEARING.

In predicting the possible discovery of oil and gas in any region the method now generally employed, with great success, is to examine thoroughly every feature of the geology of the region, especially the features that determine or affect the origin and accumulation of oil and gas; and next, to compare carefully the features thus disclosed with the features of the nearest fields in which oil is obtained from the formations found in the field just explored. Conclusions based on work of this kind done by thoroughgoing and competent geologists in many parts of the country score more than sixty per cent in the discovery of new oil and gas pools. This is roughly ten to one better than the old-style methods, which took little account of certain geologic details now known to be very significant; and as geologic investigation and experience in the oil fields go forward the percentage of success is increasing. Nevertheless, the drill must give the final answer to the question whether oil or gas will be found at any specific point in wildcat territory.

AMERICAN CONSUL FAVORS METER-LITER-GRAM.

Strong support for its metric standardization campaign has just been received by the World Trade Club of San Francisco from B. Harvey Carroll, American Consul at Naples, Italy. Mr. Carroll has written unofficially: "In more than a score of reports to the department, I have taken occasion to advocate the abolition of the imbecility of the English system of weights and measures and the adoption of the metric system." Mr. Carroll declares that he is in entire sympathy with the movement to secure metric standardization throughout the world. Many other American consuls throughout the world have expressed the same belief in metric standardization.

PROBLEM DEPARTMENT.

Publisher's Notice.

It is with great regret that we are obliged to announce the retirement of Dr. Hassler from the editorship of the Problem Department. Under his management it has attained great success. We are exceedingly fortunate, however, in securing Mr. Joseph A. Nyberg, of the Hyde Park High School, Chicago, to manage the affairs of this most important phase of this Journal.

Conducted by J. A. Nyberg,

Hyde Park High School, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. If you have any suggestion to make, mail it to him. Address all communications to J. A. Nyberg, 1044 East Marquette Road, Chicago.

SOLUTION OF PROBLEMS.

636. *Proposed by Walter Warne, State College, Pa.*

Obtain all the values of x and y in the equations

$$\begin{aligned} x+y &= 14-y^2, \\ x^2y^2+xy^3+xy &= 600-x^2y^4-2x^2y^3 \end{aligned}$$

637. *Proposed by A. Pelletier, Ecole Polytechnique, Montreal, Can.*

A, B, C are three numbers having, respectively, α, β, γ digits. Find the number of digits in the expression $(AB/C)^n$.

[There was an error in the printing of these problems, and the corrected forms were not published in time for solutions to arrive. The solutions to these will be published at the same time as the solutions to the problems proposed this month—in September.—*Editor.*]

626. *Proposed by Walter McNelis, Philadelphia.*

Prove the following equations are consistent and solve

$$\begin{aligned} 50l_1+250l_2+100l_4 &= 6 \\ 265l_3+200l_6-250l_2 &= 0 \\ 110l_5-100l_4-200l_6 &= 0 \\ 50l_1+265l_3+110l_5 &= 6 \\ l_1-l_2-l_3 &= 0 \\ -l_1+l_4+l_5 &= 0 \\ -l_4+l_6+l_2 &= 0 \\ l_3-l_5-l_6 &= 0. \end{aligned}$$

Solution by M. G. Schucker, Pittsburgh, Pa.

Equation (4) may be derived by summation of equations (1), (2), and (3). Hence, equation (4) may be neglected in the solution. The determinant of the other seven equations taken in order,

$$\begin{vmatrix} 50 & 250 & 0 & 100 & 0 & 0 & 6 \\ 0 & -250 & 265 & 0 & 0 & 200 & 0 \\ 0 & 0 & 0 & -100 & 110 & -200 & 0 \\ 1 & -1 & -1 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & -1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & -1 & -1 & 0 \end{vmatrix} = 0.$$

Hence, the equations are consistent. Also, equation (8) may be derived from (5), (6), and (7). By solving the system of the six equations (1), (2), (3), (5), (6), and (7) as simultaneous,

$$l_1 = \frac{\begin{vmatrix} 6 & 250 & 0 & 100 & 0 & 0 \\ 0 & -250 & 265 & 0 & 0 & 200 \\ 0 & 0 & 0 & -100 & 110 & -200 \\ 0 & -1 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & -1 & 0 & 1 \end{vmatrix}}{\begin{vmatrix} 50 & 250 & 0 & 100 & 0 & 0 \\ 0 & -250 & 265 & 0 & 0 & 200 \\ 0 & 0 & 0 & -100 & 110 & -200 \\ 1 & -1 & -1 & 0 & 0 & 0 \\ -1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & -1 & 0 & 1 \end{vmatrix}} = \frac{5063}{194950}.$$

Likewise,
$l_2 = 2613/194950$; $l_3 = 7/557$; $l_4 = 2633/194950$; $l_5 = 243/19495$; and $l_6 = 2/19495$

627. *Proposed by Daniel Kreth, Wellman, Iowa.*

Prove that the integral part of $(1+\sqrt{2})^x$, x odd is a multiple of 4.

Solution by Norman Anning, Orano, Maine.

Let $(1+\sqrt{2})^x = A+B\sqrt{2}$ where A and B are integers.

Then $(1-\sqrt{2})^x = A-B\sqrt{2}$.

And $(1+\sqrt{2})^x + (1-\sqrt{2})^x = 2A$, an integer.

Now, since $\sqrt{2}$ is irrational, $(1+\sqrt{2})^x$ is not an integer and, because x is odd and because $1<\sqrt{2}<2$, the quantity, $(1-\sqrt{2})^x$, which is added to $(1+\sqrt{2})^x$ is a negative proper fraction; it follows that the integral part of $(1+\sqrt{2})^x$ is 2A.

Expanding $(1+\sqrt{2})^x$ and separating rational from irrational parts,
$A = 1+(x/2)\cdot 2+(x/4)\cdot 4+(x/6)\cdot 8+ \cdots [x/(x-1)]\cdot 2^{x-1/2}$
$A-1 = 2[(x/2)+(x/4)\cdot 2+ \cdots +[x/(x-1)]\cdot 2^{x-3/2}]$

The binomial coefficient, (x/k), $(k = 2, 4, 6, \cdots, x-1)$, is an integer and since x is prime and greater than k it cannot cancel out when the denominator is got rid of and must remain as a factor of the integer (x/k).

Since $A-1$ is divisible by 2 and by x
$2A-2$ is divisible by $4x$. Q. E. D.

Note: Expressed as a continued fraction,
$(1+\sqrt{2})^x = 2A+1/2A+1/2A+1/2A+ \cdots$

638. *Proposed by Walter R. Warne, State College, Pa.*

Show that

$$\begin{vmatrix} x, & y, & z, & w \\ a, & b, & c, & d \\ d, & c, & b, & a \\ w, & z, & y, & x \end{vmatrix} = \begin{vmatrix} (x+w), & (y+z) \\ (a+d), & (b+c) \end{vmatrix} \cdot \begin{vmatrix} (x-w), & (y-z) \\ (a-d), & (b-c) \end{vmatrix}$$

Solution by Helena M. Harrington, Saint Clara College, Sinsinawa, Wisconsin.

Multiplying column 4 by (+1) and adding to column 1; multiplying column 3 by (+1) and adding to column 2, we obtain

$$\begin{vmatrix} x, & y, & z, & w \\ a, & b, & c, & d \\ d, & c, & b, & a \\ w, & z, & y, & x \end{vmatrix} = \begin{vmatrix} (x+w), & (y+z), & z, & w \\ (a+d), & (b+c), & c, & d \\ (d+a), & (c+b), & b, & a \\ (w+x), & (z+y), & y, & x \end{vmatrix}$$

Multiplying the first row by (−1) and adding to the fourth row; multiplying the second row by (−1) and adding to the third row we obtain

$$\begin{vmatrix} (x+w), & (y+z), & z, & w \\ (a+d), & (b+c), & c, & d \\ (d+a), & (c+b), & b, & a \\ (w+x), & (z+y), & y, & x \end{vmatrix} = \begin{vmatrix} (x+w), & (y+z), & z, & w \\ (a+d), & (b+c), & c, & d \\ 0, & 0, & (b-c), & (a-d) \\ 0, & 0, & (y-z), & (x-w) \end{vmatrix}$$

By Laplace's Development

$$= \begin{vmatrix} (x+w), & (y+z) \\ (a+d), & (b+c) \end{vmatrix} \cdot \begin{vmatrix} (b-c), & (a-d) \\ (y-z), & (x-w) \end{vmatrix}$$

By suitable interchanges of rows and columns in the second determinant, we get

$$= \begin{vmatrix} (x+w), & (y+z) \\ (a+d), & (b+c) \end{vmatrix} \cdot \begin{vmatrix} (x-w), & (y-z) \\ (a-d), & (b-c) \end{vmatrix}$$

Also solved by A. PELLETIER.

639. *Proposed by N. P. Pandya, Amreli, Kathiawad, India.*

A quadrilateral ABCD has AB : BC : CD : DA = 1 : 2 : 3 : 4. On DA a part, DE, is cut off equal to 3AB. Find the condition that in the triangle BCE, CB = CE.

I. *Solution by T. E. N. Eaton, Redlands (Cal.) High School.*

Construct a right triangle whose hypotenuse is three times the short side and call the larger acute angle θ.

Draw AB ($=a$) making an angle with BC equal to $180° - \theta$. Complete the "kite" ABCE. On EC set up the isosceles triangle EDC, using $3a$ as the length of the sides CD and ED. Join EA. $\angle$DEA is a straight line since $\angle AEC = \angle ABC$ by construction and $DEC = \theta$ by construction. Therefore the quadrilateral satisfies the hypothesis and EC = CB by construction. In brief, the condition is: $\angle ABC = 180° - \theta$ and $\theta = \arccos 1/3$.

II. *Solution by Norman Anning.*

In the triangle CDE,

$CD/3 = DE/3 = EC/2$,

$\cos \angle CDE = (3^2+3^2-2^2)/(2\times3\times3) = 7/9$,

$\angle CDE = \cos^{-1} 7/9 = 38° 56\ 1/2'$ nearly.

Four sides and one angle are not quite sufficient to determine a quadrilateral. There is needed, further, the statement that it has or has not a reëntrant angle. This, along with $9\cos D = 7$ determine completely the quadrilateral of the problem.

Also solved by C. G. HUFF *and* A. PELLETIER.

640. *Proposed by Walter R. Warne.*

If $\alpha+\beta+\delta+\gamma = 360°$, change the expression

$$\cot(\alpha/2)+\cot(\beta/2)+\cot(\gamma/2)+\cot(\delta/2)$$

into a product in which δ is lacking.

Solution by Norman Anning, Orono, Maine.

If $A+B+C+D = 180°$,

$\cot A+\cot B+\cot C+\cot D$

$= (\cot A+\cot B)+[\cot C-\cot(A+B+C)]$,

$= [\sin(A+B)]/[\sin A\sin B]+[\sin(A+B)]/[\sin C\sin(A+B+C)]$,

$= [\sin(A+B)]/[2\sin A\sin B\sin C\sin(A+B+C)][2\sin C\sin(A+B+C)+2\sin A\sin B]$,

$= [\sin(A+B)]/[2\sin A\sin B\sin C\sin(A+B+C)][\cos(A+B)-\cos(A+B+2C)+\cos(A-B)-\cos(A+B)]$

$= [\sin(A+B)]/[2\sin A\sin B\sin C\sin(A+B+C)][2\sin(B+C)\sin(C+A)]$,

$= [\sin(A+B)\sin(B+C)\sin(C+A)]/[\sin A\sin B\sin C\sin(A+B+C)]$.

Putting $A = \alpha/2$, $B = \beta/2$, $C = \gamma/2$, $D = \delta/2$,

$\alpha+\beta+\gamma+\delta = 360°$

and $\cot\alpha/2+\cot\beta/2+\cot\gamma/2+\cot\delta/2$

$= \sin[(\alpha+\beta)/2]\sin[\beta+\gamma)/2]\sin[(\gamma+\alpha)/2]\operatorname{cosec}\alpha/2\operatorname{cosec}\beta/2\operatorname{cosec}\gamma/2\operatorname{cosec}[(\alpha+\beta+\gamma)/2]$

a product in which δ is lacking.

A similar solution was received from A. PELLETIER.

LATE SOLUTIONS.

629. W. R. WARNE.

631. W. R. WARNE (4), C. E. GITHENS.

PROBLEMS FOR SOLUTION.

651. *Proposed by Walter R. Warne, State College, Pa.*

If x, y, z be in harmonic progression, a, x, b in arithmetic progression and a, z, b in geometric progression, show that

$$y = 2(a+b)\left[(a/b)^{1/4} + (b/a)^{1/4}\right]^{-2}$$

652. *Proposed by Walter R. Warne.*

A V-shaped trough has an angle of 60°, and is six feet long. A sphere 12 inches in diameter is placed in it and rolls throughout its length. How many revolutions does it make?

653. *Proposed by J. Carl Kamplain, Student, University of Chicago.*

Given a triangle ABC with $a = 6$, $b = 5$, $c = r$. Find a point P such that PA : PB : PC $= c : b : a$.

654. *Proposed by C. N. Mills, Heidelberg University, Tiffin, Ohio.*

Three circles, whose radii are r_1, r_2, r_3, touch one another externally. Show that one of the sides of the triangle made by joining the points of contact, is

(1) $$2r_1\left[\frac{r_2 r_3}{(r_1+r_2)(r_1+r_3)}\right]^{\frac{1}{2}};$$

(2) The area of the triangle formed by the points of contact is to the triangle formed by the centers of the circles as

$$2(r_1 r_2 r_3) : (r_1+r_2)(r_1+r_3)(r_2+r_3).$$

655. *Proposed by C. N. Mills.*

If a, b, c, the sides of a plane triangle, be in harmonic progression, show that

$$\left[\frac{\sin A/2}{\sin C/2}\right]^2 = \frac{\cos B - \cos A}{\cos C - \cos B}$$

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones.

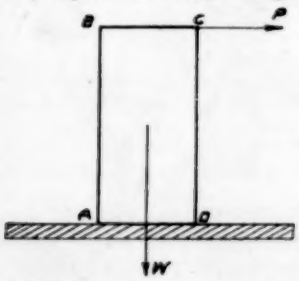
The Warner & Swasey Company, Cleveland, Ohio.

Readers are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, 10109 Wilbur Ave., Cleveland, Ohio.

QUESTIONS AND PROBLEMS FOR SOLUTION.

338. *Proposed by K. L. Pohlman, The Warner & Swasey Apprentice School, Cleveland, Ohio.*

Rectangle ABCD rests upon side AD. Side AD = ½AB. Coefficient of friction = ⅙ If it be pulled by a horizontal force P at C till motion ensues, determine if it will slip on the floor, or begin to turn over round D.



339. *Test VI. Technical Information.*

Will readers of SCHOOL SCIENCE AND MATHEMATICS *try this test upon*

themselves and send in the results? Answers will be treated confidentially.

(Please note that this test is copyrighted by Carnegie Institute of Technology.)

TEST VI, TECHNICAL INFORMATION, FOR COLLEGE FRESHMAN AND HIGH SCHOOL SENIORS.

(*Prepared for Society for the Promotion of Engineering Education, Committee No. 22 on Intelligence Tests.*)

(L. L. Thurstone, Division of Psychology, Carnegie Institute of Technology, Pittsburgh, Pa.)

Name.....
(Last Name) (Initials)

College..... Date.....

The object of this test is to determine how much technical information you have absorbed not only in school, but also in your activities outside of school.

Each question has four printed answers and you are to underline one of the four printed answers. Thus:

Electricity is conducted by
ropes wires twine yarn

Underline the word "wires" because that makes the truest statement. You will do likewise with all the statements in this test.

Do not write any other answers. Simply underline one, and only one, of the four printed answers.

Be sure to underline one of the four answers for each question even if you have to guess. Even if you do not know the answer you will make a guess. Try to guess the answer which looks to you the most reasonable even if you know very little about the question.

You are expected to finish this test. Take as much time as you reasonably need to answer all the questions. When you have answered all the questions, return this test to the examiner and leave the room quietly.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO BEGIN.

(Copyright 1919, by Carnegie Institute of Technology. Form S 1551.)

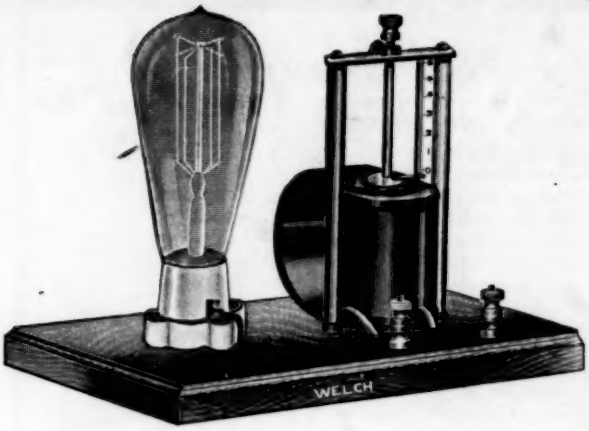
UNDERLINE ONE OF THE FOUR ANSWERS FOR EACH STATEMENT.

1. A magnet attracts
brass copper iron platinum
2. The rear hub of a bicycle is often fitted with a
coaster brake cyclometer grease cup tail light
3. An air rifle uses for ammunition
.22 short BB shot .32 center fire CB caps
4. Oil is ordinarily used as a lubricant when drilling holes in
cast iron steel wood brass
5. A common diaphragm opening for snap shots is
8 64 128 400
6. In making a core for an induction coil one ordinarily uses
mahogany rubber copper iron
7. Harley-Davidson is the name of a
motor cycle electric clock wireless detector aeroplane
8. The distributor in an automobile is a part of the
cooling system ignition system oiling system transmission
9. R. P. M. represents
volume speed content direction
10. In order to make solder adhere to metal surfaces it is necessary to use
oil flux glue gasolene
11. To keep the barrel of a target rifle in good condition one often uses
carborundum paste dutch cleanser vinegar three-in-one oil
12. Low voltage fuse wire ordinarily contains
lead silver brass platinum
13. The regulation Ford is equipped on the rear wheels with tires of a diameter of
2½" 3" 3½" 4"

14. The boiling point of water on the Fahrenheit scale is
212° 312° 512° 100°
15. A gas engine in which the explosion takes place in each cylinder once in every two revolutions of the shaft is called
one cycle two cycle three cycle four cycle
16. The material used for trolley wire is
galvanized iron aluminum copper brass
17. DeForest invented the
triple-valve vacuum-valve needle-valve safety-valve
18. What size wire is most commonly used for wiring a house for 110 volts?
6 8 14 20
19. The wrench to turn small sizes of gas pipe should be a
socket monkey Stilson box
20. Broaches are used in a
lathe boring mill drill press arbor press
21. What is the approximate daylight limit in miles radius of a quarter kilowatt spark gap wireless telegraph sending set?
one mile 10 miles 200 miles 1000 miles
22. The motion of the table of a planer in a machine shop is
rotary reciprocating continuous endless
23. Bricks are made of
clay granite sandstone gneiss
24. The gears used on a lathe for thread cutting are known as
helical bevel spur worm
25. The current obtained from dry cells is
rotary interrupted direct alternating
26. The purpose of back gears on a lathe is to
increase the speed cut threads turn tapers decrease speed
27. Balloons are filled with
compressed air hydrogen oxygen steam
28. Circles which pass through the North and South poles are called
equator latitude longitude equinox
29. Board measure pertains to
lumber cardboard paper metal
30. A file may be made to "bite" into cast iron by using
vaseline tallow beeswax chalk
31. The top of a shop bench is often made of
Douglas fir mahogany walnut maple
32. A split pulley on a shaft is held fast by
cement solder friction glue
33. A fillet in pattern making is ordinarily made of
leather wire twine sand
34. A bearing for a steel shaft, to wear well, is sometimes made of
cast iron bronze tool steel zinc
35. A file is held square across the blade and level in filing a
cross-cut saw rip saw back saw coping saw
36. A turret lathe is used in machining
bolts nails hammers scissors
37. Which of the following terms indicates gages of electric wires?
Winchester Roebling Brown and Sharpe Westinghouse
38. The chips made by a lathe in turning metals are long spirals when turning
cast iron steel aluminum zinc
39. In ordinary pattern work patterns are made of
fiber rubber leather wood
40. Pica is a term used in
navigation printing artillery railroading
41. The diameter of a Ford piston is
2½" 3½" 4" 4½"
42. Locks are manufactured by
Corbin Maydole Starrett Brown & Sharpe
43. Which instrument is used to measure temperature?
dynamometer condenser pyrometer rheostat

44. A file is made of
Bessemer steel machinery steel cold rolled steel high carbon steel
45. The number of leveling screws on an ordinary transit for surveying work is
2 3 4 6
46. A soldering iron is made of
iron steel copper tin
47. How many legs are there in the tripod of an ordinary surveying transit?
one two three four
48. If you had to make a strong bolt but could not get steel to make it of, your next choice would be
cast iron lead wrought iron brass
49. The blade is ground on the upper side in a
smooth plane block plane rabbet plane jack plane
50. Which of these screws requires a counter sunk hole?
fillister head round head hexagon head flat head
51. Which of these taps has the largest diameter?
⅜″ pipe tap ½″ U. S. Std. tap ½″ S. A. E. tap ½″ pulley tap
52. The contours on a topographic map indicate
roads elevation streams longitude
53. Edge tools and cutlery are made of
cold rolled steel wrought iron carbon steel cast iron
54. To whet a plane blade one should use
emery cloth a file sand paper an oil stone
55. The width of a standard gage railroad track is
4 feet 4 feet 8½ in. 5 feet 5 feet 6 in.
56. Shellac varnish is thinned by
distilled water alcohol turpentine gasoline
57. Shafting is sometimes made on the
planer miller shaper lathe
58. What material is used in making the insulation of common bell or annunciator wire?
wool rubber cotton silk
59. Ordinary concrete contains
asphalt cement glass rubber
60. An automobile cylinder should be finished to a very smooth even surface. This is sometimes done by
lapping milling filing turning
61. Aeroplane motor frames are sometimes made of
brass copper steel cast iron
62. Incandescent lamps in houses are ordinarily wired in
tandem multiple series
63. A good fabric for aeroplane wings is
wool cotton linen canvas
64. A star wheel is used in a
motion picture machine sewing machine steam engine bicycle
65. The split nut on a lathe is used for
reducing speed reversing speed driving carriage increasing speed
66. A window sash holds the
jambs casings glass sills
67. The L. S. Starrett Co. manufactures
tools soap furniture automobiles
68. Small angles are measured on an ordinary surveying transit by a
vernier capstan tripod leveling screw
69. A connecting rod bearing is sometimes made of
aluminum steel bronze cast iron
70. One part of the door is the
jamb head sill panel

71. A man six feet tall is best fitted with a diamond frame bicycle when the frame measures
15″ 18″ 24″ 36″
72. In sawing off a 10″ board one uses a
cross-cut saw rip saw coping saw turning saw
73. A cotter pin is ordinarily used to hold in place a
nut side curtain spare tire spark plug
74. The joints in most picture frames are
dovetailed mortise and tenon butted mitered
75. The current used by a two-phase motor is
D. C. static A. C. storage battery
76. Ordinary house paint contains
oil water alcohol gasoline
77. The spark plug on a gasoline engine is located on the
crank case cylinder manifold carburetor
78. In boring a small hole one sometimes uses a
mitre brace and bit T-bevel spoke shave
79. A gauge point on a carpenter's gauge should extend about
1-16″ ½″ 7-8″ 1½″
80. What is the standard commercial wave length for ships?
200 600 900 1200
81. A mallet should be made of
white pine cypress bass wood beech
82. Which of these cars have air cooled engines?
Packard Dodge Franklin Ford
83. Hot glue is thinned with
water turpentine alcohol linseed oil
84. The best resistance wire for electrical circuits is
silver copper German silver platinum
85. The joists in a building support the
roof foundations chimney floor
86. Which of the following metals can be case-hardened?
wrought iron aluminum copper babbitt
87. A frame building is constructed mainly of
brick wood steel tile
88. To keep a motor commutator clean use
oil sand paper emery cloth file
89. Shingles are nailed to the
joists sheathing jambs sills
90. Machine screws come in numbered sizes No. 1 to No. 30. Which is the smallest of these?
No. 6 No. 20 No. 12 No. 24
91. The uprights of a frame building are called
rafters lintels joists studding
92. Lead plate storage batteries are ordinarily filled with a dilute solution of
hydrochloric acid acetic acid sulphuric acid nitric acid
93. When gluing two pieces of wood together the surfaces should be
shellaced painted stained straightened
94. The cheapest heating system to install in a house is
steam hot water electric warm air
95. In cabinet work one most frequently uses
oak hickory catalpa cypress
96. The volt is a measure of
current pressure resistance power
97. A roof which has the shape of a four-sided pyramid is called
gable gambrel mansard hip
98. Small twist drills come in numbered sizes from No. 1 to No. 60. Which is the largest of these?
No. 52 No. 12 No. 21 No. 36
99. Those parts of a staircase into which the treads and risers are framed are called
stringers spandrels newels brackets
100. Auger bits increase in size in steps of
1-16″ 1-8″ 1-4″ 1-64″



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As a student piece it presents a very valuable test for the student to make measurements on, and the current and voltage in this coil when the core is in different positions may be measured. This will enable the student to calculate the apparent resistance and he will find that resistance is not constant as *Ohms law only* would show. The instrument is provided with a scale on one side so that the student may know exactly the length of air gap existing in the core, and some very definite ideas may be gained as to choking effect of an alternating current.

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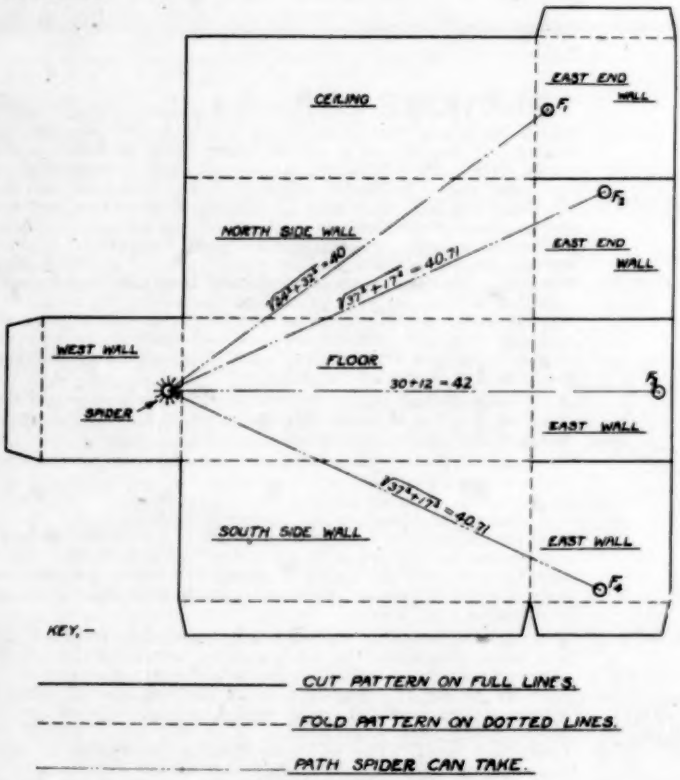
SOLUTIONS AND ANSWERS.

336. *Proposed by Worcester R. Warner to the boys in The Warner & Swasey Co. Apprentice School.*

A room is 30 feet long, 12 feet wide and 12 feet high. A spider starts from a point in the middle of the end wall of the room one foot from the floor and crawls to a fly in the middle of the opposite wall one foot from the ceiling. How far does the spider crawl if he goes by the shortest path?

Solutions from J. O. Hassler, Chicago, Ill.; E. W. Triess, Newark, N. J.; H. L. Caillet, Johnstown, Colorado; James C. Meeds, Sophomore Oakmont H. S., Oakmont, California; H. W. Corzine, Cleveland, Ohio.

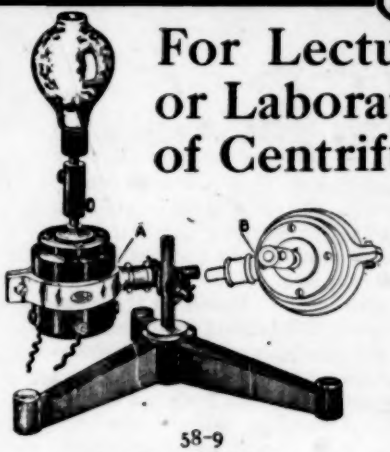
The following pattern gives a complete solution of the problem, showing all the straight line paths the spider may use in approaching the fly. If the figure is cut and folded as directed—printing outside—the four F's will be found to coincide. The solutions will appear on the outside of the model.



BOOK REVIEWS.

General Mathematics, by Raleigh Schooling, in charge of mathematics, The Lincoln School of Teachers of Teachers College, New York City, and Wm. D. Reeve, Teachers' Training Course in Mathematics in the College of Education, and Head of the Department of Mathematics in the University High School, The University of Minnesota. Pages xvi +488. 13.5×19 cm. $1.48. 1919. Ginn and Company, Boston.

The preface and introduction should be reprinted here since they present such a clear and convincing argument for a thorough reorganization of the course in secondary mathematics. The authors are especially well



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Modern Junior Mathematics, Books I and II, by Marie Gugle, Assistant Superintendent of Schools, Columbus, Ohio. Pages ix+222, xiv+239. 13×19cm. 1920. The Gregg Publishing Company, New York.

Book I is planned for a year's work in the seventh grade, or the first year of the junior high school, and aims to train the pupil in that part of arithmetic used in everyday business which he can understand, to develop skill in rapid calculation, to develop the habit of checking results, to develop habits of thrift, and to train the pupil in the simplest elements

of bookkeeping. The problem material and methods are taken as far as possible from actual business practice and will do much to train boys to become good business men and girls to become thrifty housekeepers. The method of presentation is admirable. First the use of a topic is shown then a feeling of need is created as a motive for learning and after this the topic is developed in a natural way with applications and practice to give the pupil a sense of really knowing the subject.

Book II covers a year's work in the eighth grade. Based on the mensuration and construction of plane figures it is planned to extend the pupil's knowledge of arithmetic, to train the hand to use the simple drawing instruments, to train the pupil to see geometric forms in nature and in buildings and other structures and to appreciate their use in design, and to introduce general number in a natural way that will give algebraic expressions a real meaning to the pupil so that he will use them readily as convenient and practical tools. The necessary equipment for the department and for each pupil is indicated. The work is well planned so that the pupil may advance slowly by doing and thinking for himself. It is certain that this series of books will be deservedly appreciated and widely used. H. E. C.

Plane Geometry, by Mabel Sykes, Instructor in Mathematics, Bowen High School, Chicago, and Clarence E. Comstock, Professor of Mathematics, Bradley Polytechnic Institute. Pages xii+322. 14×20 cm. 1919. Rand McNally and Company, Chicago.

It has been stated that the object of geometry teaching is threefold: (1) That pupils may acquire a certain number of geometric facts; (2) That they may be able to apply their geometric knowledge to the solution of problems; (3) That they may get some training in sound reasoning and precision of statement. This book seems to place the emphasis on the third object. But the second object is attained, at least as far as geometric problems are concerned. The analytic method of attack is used throughout. In the proof of nearly all the theorems the first step is the analysis, and this is given in such detail that the pupils who study this book will be thoroughly trained to invent their own proofs.

Moreover, the work is arranged to throw emphasis on the important theorems and methods in order to make the analysis effective. Hence the division into chapters is based on the important general ideas in geometry, congruence, ratio, area, similarity, and so on. There is an abundance of exercises, some with concrete setting taken from surveying, physics, architecture, and industrial design. The book was written "with the firm conviction that it is possible to give high school young people a more systematic training in the science of geometry than is furnished by any textbook on the market today." In the choice of type and paper, the uncrowded appearance of the pages, and all the details that go to the production of an attractive book, the publishers have added to the excellence of the work of the authors. H. E. C.

Intermediate Text Book of Chemistry, by Alexander Smith, Head of Department of Chemistry, Columbia University. 1st edition. Pages vi+520. 3.2×14.4×20.9 cm. Diagrams, graphs and several full page illustrations. Cloth. 1919. $2.25. The Century Co.

This new chemistry text, as its name implies, is intended to be used especially by those students who need some foundation in the general facts and principles of inorganic chemistry for subsequent use in domestic science, agriculture, etc., but who do not intend to follow chemistry intensively. The applications of chemistry are given more attention than in the more complete college texts of the same author.

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Among the points that differentiate this text from its predecessors we note, first, that more attention is given to simple organic chemistry (chapters xvii, xviii and xix, chapters xxxii and xxxiii and chapter xxxvii); second, in chapters xxxi and xliii, we have an outline of qualitative analysis under the headings "The Recognition of Substances, a Review of the Non-metallic Elements" and "Recognition of Substances, II Metallic Elements."

Among the topics treated in the organic chapters are Fats, Soaps and Related Compounds, Explosives and Plastics, Plants, Fuels and Foods, and Agriculture. With the exception of this leaning toward a fuller treatment of applications of chemistry the text resembles in most respects the excellent series of inorganic chemistries of which it forms the latest member. F. B. W.

MEETING OF ASSOCIATION OF TEACHERS OF SECONDARY MATHEMATICS IN NORTH CAROLINA.

On January 30 and 31, the annual meeting of the Association of Teachers of Secondary Mathematics in North Carolina was held at the North Carolina College for Women, Greensboro, N. C.

The women who were in attendance were entertained while in Greensboro by the college. More than forty teachers were present. On the afternoon of January 30, the college gave an informal tea in honor of the Association.

Mr. W. W. Rankin, professor of mathematics, University of N. C., who is the executive Secretary of the Association, is on a year's leave of absence for graduate work at Columbia University. His absence necessitated double work for the President, Miss Cora Strong, of the N. C. College for Women, in planning the program and in making other arrangements for the meeting.

Professor L. C. Karpinski of the University of Michigan was the distinguished speaker invited to address the Association. On Friday evening he made his first address, an illustrated lecture on "The History of Algebra." This meeting was open to all the college students of the city and also to the students of the near by colleges. His second lecture, "The Methods and Aims in the Study of Mathematics," was given on Saturday morning. On Saturday afternoon he spoke on "The Practical Applications of High School Mathematics." He made the teachers realize how intensely alive and useful their science is, showing how the plan of a large auditorium, the reflector of an automobile, the arch of Hell Gate Bridge, the path of a projectile and the orbit of a comet are all reflections of an algebraic equation, and how the price of a railroad ticket may really be said to depend upon the binomial theorem.

Miss Irene Templeton gave a summary of the recent preliminary report of the National Committee on Mathematical Requirements on the "Reorganization of the First Courses in Secondary School Mathematics." A committee was appointed to get the consensus of opinion of the teachers of secondary mathematics in North Carolina and communicate with Professor J. W. Young, chairman of the National Committee.

The following officers were elected for the year 1920: President, Mr. A. W. Hobbs, University of North Carolina; First Vice President, Mr. T. C. Amick, Elon College, Elon, N. C.; Second Vice President, Miss Fannie B. Robertson, Fayetteville High School, Fayetteville, N. C.; Recording Secretary, Miss Birdie McKinney, Teachers Training School, Greenville, N. C.; Permanent Secretary, Mr. W. W. Rankin, University of N. C.—Maria D. Graham, Recording Secretary, 1919.

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THE NATIONAL COUNCIL OF MATHEMATICS TEACHERS.

A new organization which promises much for the teaching of mathematics in the high schools of the country was launched February 24, in Cleveland, Ohio, in conjunction with the meeting of the Department of Superintendence of the N. E. A. The organization is called The National Council of Teachers of Mathematics.

The meeting was held in the Hotel Hollenden, Alfred Davis, of the Soldan High School, St. Louis, was elected secretary. Mr. J. A. Foberg of Chicago presided at the forenoon session, while Mr. D. W. Werremeyer, of Cleveland, presided at the afternoon session.

The following items were of especial interest in the program

"The Claims of Mathematics as a Factor in Education," by Professor C. N. Moore, of the University of Cincinnati.

Report of the National Committee on Mathematical Requirements, by Professor J. W. Young, of Dartmouth College. A discussion of this report was led by E. R. Smith, Principal of the Park School, Baltimore; and by Frank C. Touton, High School Inspector for Wisconsin.

"Mathematics of the Junior High School," by William Betz, of the Lincoln School, New York City. A discussion of this paper was led by Miss Marie Gugle, Assistant Superintendent of Schools, Columbus, Ohio.

Commissioner P. P. Claxton, of Washington, D. C., gave a brief address at the afternoon session.

Much enthusiasm was manifested by all who were present. It was a red letter day for the teaching of mathematics.

The committee appointed to consider the establishing of an official journal made the following report which was adopted:

"Your committee submits the following recommendations with reference to an official journal.

"1. Some official organ or journal is indispensable to the work of the National Council of Mathematics Teachers.

"2. It seems highly preferable that no new journal be launched by the Council.

"3. The journal shall be administered by an editorial board of from three to five members and an editor-in-chief. The members of the board shall be teachers of elementary and secondary mathematics, except one member who shall be an advisory member representing the college group.

"4. The appointment of the editorial board shall be vested in the Executive Committee of the Council.

"5. Your committee has been unable to negotiate in any detail-way with existing journals.

"J. R. Clark, Chairman, William Betz, D. W. Werremeyer, Charles Ammerman, W. D. Reeve."

The Constitution for the National Council of Mathematics Teachers:

I. NAME.

This organization shall be known as the National Council of Teachers of Mathematics—those who are primarily interested in elementary and secondary mathematics.

II. OBJECTS.

The purposes of this organization shall be:

1. To secure a greater degree of cooperation and solidarity among the teachers of mathematics.

   (a) To provide for wide publicity of important reports and addresses related to mathematics and the teaching of mathematics, through an official organ and other publications.

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(b) To vitalize and coordinate the work of the many organizations of mathematics teachers throughout the country.

2. To bring the interests of mathematics to the attention and consideration of the educational world.

III. Time and Place of Meeting.

Regular meetings of the Council shall be held annually in connection with the meeting of the Department of Superintendence of the National Education Association.

IV. Membership.

Membership in the Council shall be of two kinds: individual and collective.

All persons who are in sympathy with the work of the Council shall be eligible to individual membership.

All organizations of mathematics teachers shall be eligible to collective membership.

The annual dues of individual members shall be

The minimum dues for collective membership shall be three dollars for each organization of less than fifty. For each additional hundred members, or fraction thereof, the dues shall be an additional five dollars.

V. Management of the Council.

1. Officers.

The officers of the Council shall be a President, a Vice President, and a Secretary-Treasurer. Their duties shall be those commonly pertaining to these offices. The President and Vice President shall be elected for a term of one year. The Secretary-Treasurer shall be elected for a term of three years.

2. Executive Committee.

There shall be an Executive Committee of nine members, three of whom shall be the officers. The remaining six shall be elected, two each year, to hold office for a term of three years; except that at the first meeting, two shall be elected for one year, two for two years, and two for three years.

The Executive Committee shall manage the business of the Council, authorize the appointment of committees, and fill vacancies in office.

3. Nominations.

At each annual meeting the President shall appoint a nominating committee of three members who shall report nominations for officers and for members of the executive committee.

VI. Amendments.

This constitution may be amended by a two-thirds vote of the members present at any regular meeting.

H. O. Rugg, Chairman, E. R. Smith, O. M. Austin, Marie Gugle, J. A. Foberg.

Officers elected: President, O. M. Austin, Oak Park, Ill.; Vice President, H. O. Rugg, New York City, N. Y.; Secretary-Treasurer, J. A. Foberg, Chicago, Ill.; Executive Committee: For three years, E. Marie Gugle Columbus, Ohio; Johnathan Rorer, Philadelphia, Pa.; for two years, Harry Wheeler, Worcester, Mass.; for one year, W. D. Reeve, Minneapolis, Minn.

ALFRED DAVIS,
Secretary of the Cleveland Meeting.